

**The Shape of Uncertainty:  
Insurance Underwriting in the Face of Catastrophe Risk**

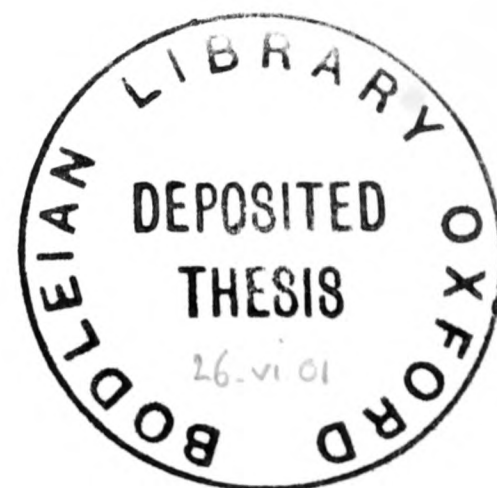
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**Thesis submitted for D.Phil.**

**Trinity Term 2000**



## **Abstract**

### **The Shape of Uncertainty: Insurance Underwriting in the Face of Catastrophe Risk Mojdeh Keykhah**

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In this thesis I study the nature of decision making under uncertainty in the case of natural catastrophes and reinsurance underwriting at Lloyd's of London. I begin by describing the broad context of natural catastrophes and society, which forms the basis for a market in catastrophe reinsurance. I then proceed to a review of literatures in risk, uncertainty, philosophy, and probability as a prelude to an analysis of decision making under catastrophic risk.

According to the early 20<sup>th</sup> century philosopher-economist Frank Knight, risk specified those cases in which a frequency probability could be assigned, while situations of uncertainty do not allow a frequency probability since they are unique instances. In the thesis, I make the additional argument that risk and uncertainty are not solely categories of probability, but rather categories of probability and causality.

The second main strand of the thesis refers to J.M. Keynes' work on probability which while related to frequency probability, is different in its emphasis on judgment and the assessment of information. I propose a causal framework to Keynes' weight of argument approach in terms of J.L. Mackie's causal field. With these two main ideas on probability and the addition of the causal field, the thesis presents the theoretical basis of its model of decision making.

The last component of the model is developed through a review and critique of the economic literature on decision making under uncertainty. As the literature is founded upon frequency probability definitions of risk, the thesis argues through its theoretical investigations that this approach neglects the causal element of decision making, and that uncertainty requires a broader conceptualization than simply lack of probability. This final component, decision making routines, combines both individual and organizational elements.

The empirical investigation of catastrophe risk underwriting at Lloyd's is organized into categories of decision making within a situated market context. I investigate the dominant categories and find that capital capacity and relationships drive reinsurance praxis. As an integration of its theoretical and empirical components, the thesis applies its risk decision making model. This model has implications for economic geography studies of the firm, in that it provides an epistemic and organizational basis for the formalization of tacit knowledge. The model also holds consequences for economic decision making theory, in that it integrates causal assessment in the purely probability based economic paradigm.

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*Mojdeh Keykhan*

*Oxford, England*

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## **Dedication**

Causality is like the Chimæra in Greek mythology. It cannot be grasped in its entirety, since it is itself contingent.

To my mother, father, and sister,

and to the City of London

## **INTRODUCTION**

“The Study Group views ‘risk’ as the probability that a particular adverse event occurs during a stated period of time, or results from a particular challenge. As a probability in the sense of statistical theory, risk obeys all the formal laws of combining probabilities.”

Royal Society, 1983 from Adams (1995), 8

“Nothing is a risk in itself; there is no risk in reality. But on the other hand, anything *can* be a risk; it all depends on how one analyzes the danger, considers the event. As Kant might have put it, the category of risk is a category of the understanding; it cannot be given in sensibility or intuition. As a technology of risk, insurance is first and foremost a schema of rationality, a way of breaking down, rearranging, ordering certain elements of reality. The expression ‘taking risks’, used to characterize the spirit of enterprise, derives from the application of this type of calculus to economic and financial affairs.”

François Ewald (1991), 199

“Catastrophes due to natural or man-made causes have three characteristics that distinguish them from other events of property and casualty losses. They occur infrequently and unpredictably, but can exact high costs due to their large footprint. For insurers, the large loss and footprint represent a good market opportunity, on the one hand, but great risk on the other. However, infrequent occurrence drives volatility, which is exacerbated by the absence of norms or precedence; catastrophes do not happen often enough to establish a track record in the actuarial sense.”

Dong, Shah, Wong (1996), 201

“Risks always depend on decisions - that is, they presuppose decisions. They arise from the transformation of uncertainty and hazards into decisions (and compel the making of decisions, which in turn produce risks). The incalculable threats of pre-industrial society ...are transformed into calculable risks in the course of the development of instrumental rational control, which the process of modernisation promotes in all spheres of life...the epochal difference that distinguishes the risks of industrial society and the bourgeois social order from the hazards and demands of risk society ...occurs at the moment when the hazards which are now decided and consequently produced by society *undermine and/or cancel the established safety systems of the provident state’s existing risk calculations*...Anyone who inquires as to an operational criterion for this transition has it to hand here: *the absence of private insurance cover*...Industrial society, which has involuntarily mutated into risk society through its own systematically produced hazards, balances *beyond the insurance limit*. The rationality on which this judgement is based derives from the core rationality of this society: *economic* rationality. It is the private insurance companies which operate or mark the frontier barrier of risk society.”

Ulrich Beck (1996), 30-31

Why is it so difficult to offer a universal definition for risk? An answer may be provided in the diversity of the above quotes to approach risk from different perspectives. Risk as the probability of adverse consequences often forms the starting point for risk studies and as an input to rational decision making (Adams, 1995). On the other hand, risk as a category of the understanding defies standardization (Ewald, 1991). This thesis contends that risk is both - an expression of expectation as in probability and of assessment, as in judgment. This thesis investigates an approach to risk governance in the private sector, of catastrophe reinsurance underwriting, in which the routines of probability - based decision making and the category of the understanding are linked.

Insurance, according to Ewald, frames the risk reality in terms of degrees of loss likelihood according to probability within categories of data classification. Dong, Shah and Wong (1996) point to the difficulty of the probability calculus as providing the tools to produce rational expectation for catastrophes, due to the scarcity of past data. Ulrich Beck (1996) also considers the “blind spot” of probability in the case of catastrophes. For him, institutional risk governance countenances catastrophe production in society, without considering the inability of insurance, founded upon expectation according to probability, to provide protection against unforeseen effects. Beck warns that it is the historically situated routinization of decision making that does not take into account the way in which risk - dangers and the distribution of hazard have changed since the industrial revolution.

For the most part, however, the authors of the quotes above did not combine their studies of risk with empirical investigation of decision making in situ - in risk sharing institutions in the private sector, such as insurance or in the public sector, such as government ministries. While conceptually thoughtful, the expositions on the risk society need a greater grounding in actual decision making practices. This thesis attempts to fill this gap: to provide both a theoretical and empirical study of risk decision making based on a fundamental philosophical inquiry into the nature of risk and uncertainty. It argues that risk studies neglect a vital component: the role of causality in defining the risk reality.

Based on an empirical investigation of catastrophe reinsurance decision making at Lloyd's and the City of London, the thesis offers an account of the categories of situated decision making and their relation to the theoretical literature. It argues that without an appreciation of the causal framework and decision context of the practitioner, proposals for risk governance will find limited applicability. Indeed, the temporal and spatial scales of catastrophe decision making in the City are quite unique and have distinct historical roots in conventions of knowledge gathering, risk sharing, and approaches to market relationships. Finally, the thesis proposes a framework for decision making based on causality and situated knowledge, and incorporates this framework in a geography of risk.

### **The Nature of Risk**

While different in their approaches, the above quotes derive from a fundamental teleology: to control and somehow manage this enigma of human affairs which is both quantity and quality, objective and subjective. In other words, risk governance

perspectives motivate conceptions of risk which in turn influence approaches to risk governance.

According to Bernstein (1996), risk derives from the Italian *riscare*, to dare. Risk governance in public institutions may be influenced by this particular incarnation. Much of risk regulation sets about defining *thresholds* to safety and welfare, within a framework of risk as measurable danger. Risk has evolved in public management *through* standards informed by the classification of data, much like in insurance. In order to provide an “objective” measure of risk, the institutions of governance employ the probability calculus. This standard of risk has been contested in terms of lay/ expert knowledges (Wynne, 1996), social perception of risk (Krimsky and Golding, 1992; Douglas and Wildavsky, 1982, Adams, 1995), and decision heuristics (Kahneman and Tversky, 1979; Goldstein and Hogarth, 1997). In academic and public debate, the category of the understanding, as sociologist François Ewald describes risk, stands in contrast to the rational calculus of risk as universal probability.

An older derivation of risk could shed further light on not only its conception, but also its *agency* in framing governance mechanisms. In the wars of the Greek empire, the risk was that parcel of land a Greek soldier was assigned to defend against enemies (Karamanolis, 1999). If the land was successfully defended, it became the property of the defender. If not, both soldier and land were lost. This mutability of risk, as danger and as opportunity, forms the basis for Ewald’s and Dong, et al.’s comments that risk is both to be exploited for potential gain and feared for potential loss. Indeed, as this thesis will illustrate, the

Janus faced risk is the *sina qua non* for an insurance market: as protector and profit seeker.

John Adams, in his book *Risk*, evaluates the role of probability and statistics in subjective and objective discourse on risk and risk analysis (Adams, 1995). He contended that a study of risk necessitates a fundamental inquiry into the bridge between inference and belief, rather than a greater amassing of information for statistical evaluation. This bridge, I argue in this thesis, is causality, described by one philosopher as “the cement of the universe” (Mackie, 1974). While there are multiple approaches to causality, this thesis proposes a particular framework based on Mackie’s causal field to form the building blocks of Adams’ bridge.

In such a proposal for the basis of risk decision making, it is essential to consider the influence of the origins of probability as concepts of both natural philosophy and individual perception. As a centerpiece of risk management, probability gained currency in the coincident rise of statistics and the need for public management of the industrial revolution at the beginning of the 20<sup>th</sup> century. State institutions began to employ “political arithmetic” as it was then known, to construct “rational” social and economic policies (Kennedy, 1983; Gigerenzer, 1989). As the quotes above suggest, however, this foundation for risk management is considerably weakened in the face of catastrophes: those adverse events such as natural or technological hazards for which the probability of occurrence is very low but the consequences are great.

Ulrich Beck (1992, 1995, 1996) argues that a lack of foresight and participatory deliberation in societal decision making institutions have brought a greater potential for catastrophes. He expounds on the potential for technological disasters, runaway industrialization, and environmental calamity. One related example in this thesis is the expansive development of areas in hazard prone locations, such as in flood plains in the United States and the UK. The decision to build in these regions are often made without concern for long term consequences due to vulnerability from natural hazards, but rather focuses on the immediate economic benefits. Hurricane Andrew, amounting to the greatest insured loss in history, and the windstorms of 1987 in the UK both indicate the increasing exposure of human populations to large levels of loss.

In his critique of current institutional practices, Beck claims that the present age requires a different conception of modernity, one that is not rooted in industrial society. The new era, according to Beck, is characterized by “reflexive modernization”: *reflexive* in the automatic decision making patterns reinforcing a social infrastructure of risk governance birthed during the rise of statistics, the calculus of risk management and the industrial revolution. Beck contends that the current age is not characterized by the social distribution of goods as in industrial society, but rather the social distribution of risks. Moreover, reflexive modernization unknowingly proceeds to promote ever greater hazards without accommodating society’s ability to cope with the consequences, since these consequences are not primary concerns of modern institutional decision making.

The age is also reflexive in the *reflection* on shifting bases of risk knowledges and the mismatch of risk management practices shaped by industrial society and the catastrophe potential society currently promotes. In other words, the calculus of probability, as situated in the decision mechanisms of institutions, cannot accommodate the nature of extremes. Beck argues that due to the limits of the probability calculus, catastrophes are those events for which insurance, a pillar of risk protection, can neither estimate nor compensate.<sup>1</sup> According to Beck, probability as the symbol of economic rationalism faces an impasse as the measurement of *societal thresholds*.

If the private insurance sector, due to its risk acceptance and risk distribution role, is on the frontier barrier of the risk society, it would appear imperative to prize open the structuralist narrative to investigate reflexive decision routines in action, within a situated organizational and cultural context. Beck's risk society is curiously context free, with neither a discussion of situated decision making, nor an exploration of causality in risk. The implications of Beck's vision of risk governance are substantial, not the least of which is the production of vulnerability through greater exposure to natural hazards.

### **The Risk of Nature**

Over the past 15 years, catastrophe risk has become a particularly salient theme of the insurance industry. In the decades before 1987, insured catastrophe losses did not exceed \$1 billion per event. Since 1987 there have been more than fifteen events to top this "threshold" of financial and perceptual proportions. Indeed, the trend in catastrophe

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<sup>1</sup> Beck cites technological accidents from chemical plants, global environmental problems (Beck, 1996).

claims have soared beyond precedent, representing a step change in the magnitude of losses (Dlugolecki, 1996). The close succession in time of mega disasters in highly insured regions, such as Hurricane Andrew affecting the greater Miami area in 1992 and the Northridge earthquake near San Francisco in 1994, has strained the willingness of the private insurance industry to provide coverage to hazard geographies, a *prima facie* symptom of Beck's risk society. It has been mostly the *reinsurance* sector, as catastrophe coverage providers to primary insurers, that has borne the brunt of disaster claims in the case of catastrophe risk (Dlugolecki et al., 1996).

This thesis argues that these large financial losses are not only due to external events, but also the *internal decision routines* of reinsurance praxis. In other words, it is not only the external causes, but also the institutional *conditions* of loss affected by organizational and professional conventions, that are at issue. It is for this reason that an empirical investigation of the categories of decision making in institutional contexts is critical for evaluations of risk governance.

Reinsurance expectation routines have traditionally employed past loss values as an indicator of potential future losses. This purely inductive reasoning is prone to surprise, since conditions of portfolio exposure to natural hazards have been changing. For example, the number, density and values of insured properties have greatly increased since the 1960s, rendering past loss values incommensurate with current loss potential. Moreover, trends in climate variability could undermine the inductive epistemology of return period forecasting of natural perils. Return periods require substantial data on past

events in order to provide a statistical probability, or expectation, of future occurrence.

Catastrophe risk is hardly amenable to such actuarial calculation. Many types of extreme hazards shadowing societal development share this category, including earthquakes, windstorms, hurricanes, and floods.

How does the reinsurance sector manage catastrophe risks? How does the approach to catastrophe risk elucidate patterns of expectation, assessment and decision making in this global financial market? What are the consequences for an assessment of social vulnerability over time? For an evaluation of limits of probability in risk an uncertainty? For an appraisal of the economic decision making literature? What are the new challenges facing this market and how do they relate to the nature of risk decision making itself?

This thesis first approaches these questions within a study of probability, since it is upon this basis that both institutional risk decision making and insurance expectation of loss proceeds. Economist Frank Knight at the beginning of the 20<sup>th</sup> century anchored the definition of risk and uncertainty in the probability calculus (Knight, 1921). Knight defined risk as that economic expectation which can be measured through statistical probability. Uncertainty, on the other hand, represents unique cases which are not estimable using probability. How then do decision makers approach uncertainty?

Geographer John Adams argues that “In the face of uncertainty, both scientists and theologians fall back on belief.” (Adams, 1995: 18) Knight similarly points to “habits of mind,” guiding decision making under (statistical) uncertainty. The thesis argues that

such *routines of thinking* are formed through the inductive reasoning and causal framework of the practitioner. Induction of past decision outcomes, combined with the causal framework (mostly tacit) of the decision maker provide a shape to uncertainty. A main conclusion of the thesis' theoretical investigations is that pace Knight, *risk and uncertainty are not simply categories of probability, but also of causality*. It is rather surprising, therefore, to note that among the economic decision making literature, causal frameworks are neglected.

Risk in the economic decision making literature represents a class of decision problems within expected utility theory. The literature assumes an isolated decision maker seeking to maximize across the full range of choices (comprising probabilities and outcomes). The model of expected utility is founded within mathematical expositions of normative rationality, a rationality of outcomes. This literature has been contested by several economists, such as Nobel laureate Herbert Simon, who point to the importance of decision processes (as a definition of rationality), over decision outcomes. Simon in particular also states that organizational and sociological elements are necessary (Simon, 1986). This thesis builds on Simon's view that decision making occurs within "bounded rationality", i.e. that decision makers choose satisficing outcomes, not maximizing outcomes due to the constraints of human cognition and information processing within organizational contexts. At the same time, this work goes beyond bounded rationality in developing a framework for the causal underpinnings of choice and the selection and judgment of information.

The behavioral psychology literature has also contested expected utility, arguing that decision experiments have proved it to be invalid and failing to correspond to human decision making tendencies (Kahneman and Tversky, 1979; Hogarth and Reder, 1986; Goldstein and Hogarth, 1997; Thaler, 1992). Kahneman and Tversky's prospect theory typifies the approach of the behavioralists to mathematize the contraventions of expected utility. While providing experimental evidence that the (essentially mathematical) assumptions of expected utility decision making do not hold, the behavioral literature for its part remains removed from natural contexts. This thesis addresses this lacunae by providing a situated account of decision making under uncertainty in practice.

Beck brings forward as a symptom of the risk society the limits of probability in the face of catastrophe risk. However, he does not explore the nature of probability as grounded in a conceptual bifurcation. In elucidating the risk debates in the economic decision making literature and the risk sociology literature, this thesis also provides a history of ideas approach to probability. The historical account of the probability concept reveals its multifaceted status not only as measurement of empirical reality, but as degree of belief as well (Hacking, 1975; 1990). Probability as founded on non statistical knowledge or assessment is rarely addressed in the economic decision making literature (Hogarth and Goldstein, 1997). Probability as weight of argument, or in broad terms as degree of belief, was formalized by economist and mathematician John Maynard Keynes (1921). The thesis adds to Keynes' approach by grafting a *causal* dimension to Keynes' acontextual framework for the evaluation of knowledge and ignorance.

Causality remains a diverse concept in the philosophical, legal, and psychological literatures. The thesis argues that the conception provided by philosopher J.L. Mackie (1974), which follows both philosophical and legal treatments, provides a basis for the discussion of causality in decision making. The thesis proposes a model of decision making based on causality and knowledge, instead of purely statistical probability, using Keynes' weight of argument approach within Mackie's causal field. It then applies this framework to catastrophe risk decision making praxis. Through this application, it proceeds to develop a geography of risk through a discussion of the roles of probability and causality.

An account of catastrophe risk decision making and society would be incomplete without a discussion of hazards geography and natural perils. Beck's risk society is present in the increasing exposure and vulnerability to natural hazards in the vast growth of settlement in areas prone to catastrophes, such as the Atlantic and Gulf coasts of the United States. Interestingly, a founding pillar of hazard geography is the economic literature on decision making under uncertainty. Simon's bounded rationality was taken as a starting point for the framework of American settlers in hazard prone regions in order to explain their "irrational" decisions to remain and indeed resettle in risky areas. The literature has since grown in its diversity of approaches and range of hazards studied. At one end of the continuum is the strict dichotomy of society and nature - promoting a view of perils as "Acts of God", as in the insurance literature (Kunreuther, 1974). At the other end is the dissolution of demarcations between society and disasters (Blaikie, et al., 1994). In the middle are examples of interactionism merging nature and society (Burton, Kates and

White, 1995; Kaspersen et al., 1996; Palm, 1990). The thesis will present several of these perspectives in addition to a philosophical analysis and critique.

## **Research Aims**

There has been a great deal written on the challenges to reinsurance from natural catastrophes (Leggett, 1993a; 1996; Tol, 1994) and on the risk society (Beck, 1992; 1996). The link has often been on formalized calculations indicating the limits of insurability according to the probability calculus. What has been lacking is an elucidation of the underwriting routines of practitioners within situated practices and market pressures. Risk, as portrayed in the combination of the quotes at the beginning of the introduction, takes elements of expectation, assessment and decision making within institutional contexts. The risk society perpetuates itself through these contours of risk yet reflexive modernization is presented as operating without agency. As the above discussion indicates, this study combines an empirical investigation of catastrophe reinsurance decision making and theoretical forays in the economic decision making, insurance, hazard, risk, uncertainty, and philosophy literatures to propose a geography of risk – a geography that takes as its starting point the causal framework of the decision maker within organizational contexts to explore expectation, assessment and decision making routines.

The thesis proposes four main innovations to the study of risk decision making:

1. Risk and uncertainty are fundamentally categories of *causality* and to a lesser extent probability, and thus risk studies should focus on causality and causal perception.

2. Expected utility, subjective expected utility and behavioral decision making neglect the role of assessment and causality in their models. A decision model that more comprehensively describes decision making under uncertainty is proposed in the thesis as the combination of Keynes' weight of argument and Mackie's causal field.
3. The analysis of the empirical is facilitated by distilling the practitioner's milieu into decision categories and stylized decision facts.
4. A more applicable framework for the study of risk decision making is through a geography of risk, comprising expectation, assessment and decision making.

This study does not employ financial analyses of reinsurance decision making, nor does it take a macro perspective on the City of London vis a vis other reinsurance milieus. It seeks to provide a stylized account of decision making and knowledge integration within a culturally and historically situated market within a market. It relies on the theoretical literature of insurance decision making, numerous insurance and risk trade publications, and interviews with underwriters, brokers, and other market participants.

While appreciative of the framework of culture theory in risk perception (Douglas and Wildavsky, 1982; Adams, 1995; Holling, 1979), this thesis does not take cultural theory as its lens due to the work's focus on the debate concerning probability and the economic literature on decision making under uncertainty. At the same time, the structural context of decision making is taken into account through a contextual, conceptual and to some extent discursive account of reinsurance praxis.

The status of the empirical in this work is to provide a case example of the theoretical framework developed in the thesis. It is also meant to illustrate how the private sector manages risk for which a probability estimate is difficult to provide. The empirical material enriches the causal framework paradigm and provides the bases for the decision categories in reinsurance underwriting. Moreover, it is through the insights of the empirical material that a geography of risk is proposed.

### **Research Methods**

The empirical investigation relied on semi-structured interviews (shown in Appendix B), participant observation, gray literature, and trade publications of the reinsurance industry. Several days were spent at the Lloyd's site, with a number of others devoted to visiting companies in their headquarters in the City. The 42 interview partners consisted of mainly underwriters but also included brokers, journalists, market regulators, authors of life-histories of City financiers, market association officials, market information providers, information technology managers, Treasury representatives, claims personnel, and syndicate executives. The interview responses were written by hand, which were then reviewed with an aim to collect common themes. Possible biases could include a non-exhaustive sample of reinsurance underwriters, and the limited glimpse into their financial world. By performing a greater search in the trade literature and conference literature, further depth to reinsurance perspectives on catastrophe risk could be gained.

Indeed, obtaining interviews with members of this highly competitive sector was not easy. There existed three main barriers: professional affiliation with insurance, intention

of the study, and methods chosen. As an Association of British Insurers' doctoral fellow, I was able to introduce my investigation as funded by neutral industry association serving the insurance community. This introduction served only as a first step, however, as the most important concern was the aim of my study of corporate practices. I explained that my purpose was to understand underwriters' decision making routines and categories within an organizational context, and that all interviews would be confidential. Thus, the approach steered away from competitive information, which would have been averse to most corporate interviews. At the same time, my analysis could be gainfully applied towards decision making strategy, thus benefiting corporate interests.

Finally, the interviews took a semi-structured format, in which general questions were prepared. The purpose was to allow the underwriters, by prompting major themes of the conceptual inquiry into catastrophic risk and uncertainty, to describe the tacit knowledge of the practitioner within an organizational and market context. Thus, the semi-structured nature of the interviews also allowed the interviewees to raise issues they considered important. At one stage, a questionnaire was considered, in order to reach a greater number of reinsurance practitioners in a standardized format. However, this approach was not taken for two main reasons. Firstly, the aim of the study was to gain insight into the tacit knowledge of underwriters. A standardized survey tool would not be the appropriate portal to this type of knowledge. Secondly, previous attempts to survey reinsurance underwriters' decision making strategies via a standardized questionnaire were unsuccessful. Indeed, the Wharton School questionnaire of reinsurers, led by Professor Howard Kunreuther, only garnered a 9% response rate, prompting the Wharton team to

conduct informational interviews among reinsurers (Kunreuther, Hogarth and Meszaros, 1993).

In addition to discerning the daily decision categories of underwriting and its tacit implementation by the practitioner as presented in Chapter 7, the empirical methodology also sought to contribute to the debate in human geography on qualitative interviewing among corporate elites (Clark, 1998a, 1998b, 1999; McDowell 1998, 1997, 1992; Schoenberger, 1991, 1992). Deriving categories as interpretive boundary work informed by semi-structured interviews and participant observation is an empirical approach within qualitative research. In many ways it mirrors critical realism and human reasoning studies (Rubin et al., 1992; Berlin, 1978; Yeung, 1997).

The human geography discussion on methodologies in qualitative research could be characterized as a struggle to justify qualitative approaches to positivist and structuralist judges (seen or unseen). Schoenberger (1991) placed emphasis on the amenability of the qualitative to satisfy “scientific” standards such as verifiability, reliability and accuracy. The standardized survey instrument ensures consistency and reliability, while the semi – structured approach may offer greater “accuracy and validity” when administered carefully since it enables a freer narrative on the part of the interviewee. In the exchange of Schoenberger (1992, 1991) and McDowell (1992, 1997, 1998) on the nature of interviews, the latter pointed to the impossibility of a pure positivist interviewing program, citing the contingency of sampling, quality of discourse, and verifiability issues. McDowell further argued for more transparency in interviewing evaluations, which take

into account the obstacles, interview strategy and the implicit goals of the researcher. In both accounts, interpretation remains a contested theme. However, it is unclear how much a positivist critique can be made of a humanist approach, i.e. one that highlights interpretation.

Many survey references endorse the positivist strictures of validity, reliability, and accuracy (in interpretation) as the standards against which “scientific” research should be compared (de Vaus, 1996). The positivist approaches in survey work have been influenced by the positivist branch of sociology, evolving partially to deflect early criticism of sociology’s “metaphysical bias” (Manicas, 1986). Qualitative and humanistic approaches on the other hand stress the quality of “Verstehen” through dialogue in ascertaining how people make sense of their reality. This thesis contends that the decision making reality in the City is greatly influenced by social practices, cultural norms, and organizational routines. It is problematic to make a positivist evaluation of these influences, and could be damaging to the entire enterprise of qualitative interviewing to do so.

Rubin and Rubin (1992) identify positivist interviewing as driven by a reductionist approach aimed at determining specific variables (generally pre-conceived prior to the interviews) with the objective of the interview being the determination of their causal connections. This approach approximates the scientific method, which has its roots in the reduction of complex systems into measurable, elementary foundations. However, the complexity of variables influencing actual human behavior, as well as the possible biases

and erroneous preconceived conceptions of the researcher warrant a more holistic and interactive investigative strategy. The underlying tenet of interpretive, qualitative interviewing is that the interviewees' own views should inform the basic conceptions of the interviewer, and that the purpose of the interviews is to learn "how people understand their worlds and how they create and share meaning about their lives." (Rubin and Rubin, 34) This interview strategy informed the approach taken in the thesis.

While a methodology based on close dialogue does confer particular advantages, it also poses important challenges, such as the thorny issue of interpretation. Interpretation depends as much on the impressions of the interviewer and interviewee as it does on the context of the interview itself. Three main corners of contention emerge from the literature: how does interpretation affect the validity of interviewing for scholarly description, how does the status of the interviewer (in terms of human physical impression and power relations) affect the quality and reliability of the interview, and how does particular close dialogue and explanatory styles affect the reflection or construction of a reality of personal interactions. In all these different cases, there is the inevitable Heisenberg Uncertainty Principle in the shadows, that the conditions of the dialogue alter the nature of the response.

According to the Rubins, interviews are to be taken as a sifting mechanism to discover what is repeated and what is unique while keeping a link with real examples, instead of imposing a framework from the outset. They caution against the pre-diagnosis of the main factors driving the problem under consideration and not allowing the interactive dialogue

and learning to take place. At the same time, it is important to be able to “norm” the interviews by realizing where possible the basis for the information and the explanatory style of the interviewee. The thesis methodology aims to allow close dialogue between practitioner and interviewer, within a semi structured, “enabling” context. Indeed, the description of approaches to risk and uncertainty revealed a consistent set of themes across interviewees. At the same time, Rubin and Rubin stress the relative nature of interviewing by highlighting the particular context of each interview. They also recommend that since one purpose of the interview is to test ideas of why things happen, it is important to discern the causal in the interviewee’s account, as was the choice of this study.

In the Rubins’ words, one is seeking a process that “helps you maintain focus on a set of themes that both closely fits what the interviewees have told you and also reaches for theoretical significance.” (Rubin and Rubin, 48) Moreover, “in building these theories, researchers listen carefully to hear the underlying building block ideas, or concepts, and the themes that both describe the culture and explain why things happen.” (Rubin and Rubin, 57)

Taking into account that there are different philosophical bases for an understanding of what is meant to be garnered by an interview, it is probably not an effective tack to base the human geography debate on justifying methods over qualms of interpretative standardization. Instead, the discussion could shift towards the aims of qualitative

research, much as has been broached by Clark (1998b) in view of close dialogue and stylized facts.

The goal of the interview according to Clark is to find common themes among the interviewees' own perspectives within a generalized study of the structural environment in which they operate. Stylized facts are a combination of general and contextual features of the empirical, they allow for analysis at the level of the local, while providing generality at the level the region. While close dialogue is itself an interpretative endeavor, and thus open to the standardization debate, Clark argues that such close dialogue provides well needed empirical grounding to theoretical explanations.

However, Clark warns against a naïve impression of close dialogue as illuminating the truth of the situation in the eyes of the participants. As mentioned earlier, this subjectivity is affected by many of the same variables as is human conversation in other settings, such as false consciousness. Depending on the interviewer's position with relation to the interviewee and the particular issues under discussion, the interview can be a unique informational source, which might well vary depending on what the interviewee wishes or can at a particular time divulge. This feature of qualitative interviews is not only due to the subjective impressions of the interviewee, but also the filter through which some of these impressions, whether accurate or not, are transmitted to the interviewer. This is a systematic methodological trait that cannot be eliminated, but with the conscious deliberation of the interviewer and careful framing of the interview, the information and impressions sought may be communicated in a more transparent manner.

## **Overview of the Thesis**

Chapter 1 of the thesis provides an introduction to catastrophe risk, reinsurance decision making, and societal issues. It details the rise in catastrophe losses to the insurance industry while taking into account the nature of risk and responsibility among different stakeholders such as property owners, government, and the private sector. The chapter discusses the role of reinsurance in catastrophic risk, and proceeds to outline the main institutional and risk assessment procedures of underwriting. Chapter 1 also develops a framework for catastrophe risk and the risk society within the temporal and spatial perspectives of the private sector.

Chapter 2 delves into the nature of risk and uncertainty within economic decision making and risk sociology. It takes a history of ideas approach to uncover the historical status and role of probability in the current risk literature. Within this historical setting the ideas of Knight on risk and uncertainty are treated. Keynes' weight of argument approach is discussed through an excursion into uncertainty. Through this overview, the chapter argues that causality is a neglected component of the risk literature. A selection of different conceptions of causality is given, and a risk decision making framework is proposed. The main elements comprise aspects of Keynes' weight of argument approach and J.L. Mackie's causal field.

Chapter 3 provides a non-specialist viewpoint of the scientific debate surrounding climate change, El Niño, and natural hazards with a comparison of reinsurers' views of the

production of perils and susceptibility to loss. A brief discussion of the increasing use of catastrophe modeling and scientific expertise among reinsurers is also given. The second part of the chapter offers a review of some of the seminal thinking in hazards geography, with a critique of the literature from a philosophical standpoint. It argues that hazards geography has neglected the causal framework in studies on societal vulnerability. In addition, it makes a further point that an over emphasis on framing the hazard problematic as vulnerability diminishes the account of agency of those in hazard prone regions. The chapter concludes with a suggestion to take the concept of vulnerability as only one of three factors, the other two being contingency and reliance.

Chapter 4 provides an introduction to the history and structure of the London market and Lloyd's, before discussing the recent events and current trends that are changing the nature of the City. It also provides an introduction to underwriting concerns within broader financial objectives and the context of underwriting. In so doing, it reflects the extraordinarily relationship intensive nature of catastrophe reinsurance underwriting.

Chapter 5 moves once again into theoretical waters to outline the two main strands in the theoretical literature on decision making under uncertainty: expected utility and behavioral economics. It critiques the absence of a reflection of the multiple meanings of probability, as discussed in Chapter 2. It argues that without a greater causal component, the literature does not add to an understanding of human decision behavior, and points to recent developments in the decision making literature highlighting causality. The chapter

concludes by commenting briefly on the contributions of the organizational literature on decision making.

Chapter 6 continues the theme of decision making, but this time with reference to underwriting decision making and assessment. It discusses empirical studies in the US and the UK, one done by a survey and the other, by participant observation. Both argue that catastrophe reinsurance underwriters do not rely solely on probability, but make decisions based on a number of heuristics and the weight of certain qualitative information, often having nothing to do with the underlying risk. Several models of underwriting are also discussed, since they attempt to provide a description of underwriters' tacit knowledge and structural uncertainties. The implications for the present study consist in the greater role for assessment and knowledge in representations of decision making, similar to the framework proposed in Chapter 2.

In Chapter 7, the empirical material is analyzed to suggest stylized decision facts of underwriting through the categories of catastrophe reinsurance decision making. The four categories are presented in detail, with a reflection of their situated integration in reinsurance praxis. The main heuristics in catastrophe risk decision making, including the causal framework of the underwriter, are illustrated with examples from risk market practices. The changing condition of the risk market is contrasted with the stable adherence by underwriters to particular cues to causality.

Chapter 8 brings together the implications of the study for the literature on risk and uncertainty with special regard for decision making and causality. It first reviews the concepts of risk and uncertainty as treated in the disciplinary literatures and reasserts that risk and uncertainty are causal categories, not categories of probability. It then discusses the importance of Keynes' weight of argument and Mackie's causal field in elaborating the literature on decision making under uncertainty. Reference is also made to how this synthesis is similar to observations of tacit and formal knowledge in the economic geography literature. Finally, the thesis results are synthesized to propose a geography of risk, combining expectation, assessment and decision making.

## **CHAPTER 1**

### **Catastrophe Risk and Reinsurance**

## **Introduction**

For over 300 years an institution of extreme dexterity in the techne of risk sharing existed in the City of London. This institution was Lloyd's. I speak in the past tense, not because the organization has receded— on the contrary, it is a vibrant honeycomb of activity.

Rather, the *institution* of Lloyd's and the centers of reinsurance in the City of London, for that matter, have changed irrevocably. The changes appeared in the guise of shocks to the system, both structural and perceptual, that held the old Lloyd's as a space of flows — information, knowledge, tradition, relationships, memories, and expectation together.

Such shocks belie the institutional mentalité, wrought by practitioners themselves, through their engagement in social practices and organizational routines. Expectations, as formed through pre-emptory causal frameworks of risk and uncertainty, become calcified and reinforced by the community of rivals that is the City. Risk is not the City's master, but rather an elusive child, bringing surprise to the financial system when individual decisions, through group identity, lead to catastrophe.

This chapter outlines the nature of catastrophes and risk. It provides a background to the shocks experienced by reinsurers due to losses from natural perils, and the shift in the market perception of catastrophes. The chapter also outlines risk decision making in reinsurance with a discussion of risk and responsibility in the public and private sectors. Finally, it will outline several essential structural components of underwriting and information flow within the market.

The problem of catastrophes is fundamentally concerned with the crossing of particular thresholds. These thresholds derive from the influences of social, economic, cultural, and technological domains of expectation and control. The thresholds are imagined and real at the same time, since a particular threshold in one economic sector or geographic region might not have meaning in another, giving rise to conflicting frames of reference for the catastrophic. Such perceptions rely on the views of the normal and the extreme within the categories of decision making. These perceptions are also influenced by organizational routines, tacit knowledge of management practices, and attitudes towards formal expertise. In addition to crossing a constructed threshold, catastrophes imply a rapid rate of change, both spatially and temporally. One role of insurance is to respond to how different types of change demarcate areas of risk and uncertainty for different environments and contexts.

The concept of catastrophes as an extreme form of risk is due to the evolution of risk as adverse consequences. Since de Moivre in the 17<sup>th</sup> century, the European concept of risk has come to be associated with the expectation of negative outcomes (Bernstein, 1996). Across cultures, however, risk usually contains a dual meaning. The Chinese have two words for risk – one as risk-opportunity, the other as risk-danger. The reinsurance underwriter understands the dual nature of risk, since risk provides premia from clients but also unknown (but not unestimable) future liability. This future liability, the claims space, is the primary anchor of underwriting the risk of catastrophes, which has very low probability of occurrence, but great consequences. Underwriters seek to reduce this claims space as much as possible in a contingent sense - they purchase reinsurance to

cover their own risk liability. This purchase of reinsurance requires a careful balancing between ceding risk- income and seeking protection from risk-liability.

The underwriters' challenge, therefore, is to grapple with a Janus faced risk on a daily basis. Serving as gate keepers of a particularly sizable component of society's risk protection requirements, underwriters take risks, accumulate risks and fear risks. The late Robert Kiln, a leading Lloyd's underwriter and syndicate chairman, clarified the multiple meanings of risk for the insurance underwriter as the probability of loss (the risk of the portfolio), the object being insured (the risk on the books) and the cause of the loss (the hurricane risk) (Kiln, 1991). The thesis uses the word risk in connection with insurance in these different senses, depending on the context. Catastrophic risk from natural perils in particular concerns the accumulation of a particular level of loss, arising either from a single large insured event or a combination of insured events.

### **The "Cognition of Catastrophe"<sup>2</sup>**

The history of changing catastrophe awareness for reinsurers began in 1986, when the All-Industry Research Advisory Council (AIRAC), a group sponsored by the U.S. property/casualty insurance industry, published a scenario of the adverse effects of two \$7 billion hurricanes on the U.S. insurance industry (AIRAC, 1986).<sup>3</sup> The study sought to reveal the vulnerabilities of the insurance sector to catastrophes, especially since there had not been a major natural disaster insurance loss since 1965, the year Hurricane Betsy

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<sup>2</sup> Jacqueline Meszaros (1997) "The Cognition of Catastrophe: Preliminary Examination of an Industry in Transition" Working Paper, Wharton Risk Management and Decision Processes Center, Philadelphia.

<sup>3</sup> The evaluation was based on a series of computer simulations by the Travelers Insurance Company.

rampaged the Florida coast. The figure represented a courageous estimate, considering that there had been no event to cross \$1 billion.

It was found that while the first \$7 billion event would damage the insurance and reinsurance sectors, the subsequent \$7 billion loss would engender major market dislocations. The simulation also revealed in figures what the insurance community already knew: that two \$7 billion losses would be more devastating than a single \$14 billion loss, due to the financial geographies and temporal boundaries of underwriting practices. As if tempting fate, in the year after the assessment had been published windstorm “87J” hit the southern coast of Britain (a once in 300 year event, resulting in \$4.4 billion in insured losses), followed by Hurricane Hugo in 1989 in the Caribbean (\$5.6 billion), a set of winter gales in Europe in 1990 (\$5.9 billion), and Typhoon Mireille in Japan in 1991(\$6.9 billion).

The clarion call to a new threshold of catastrophe sounded with Hurricane Andrew in 1992. While not quite a category 5 hurricane, its geographic track through southern Florida and the Gulf states precipitated over \$19 billion in insured losses, in a year that witnessed over \$24 billion in total catastrophe losses. Several insurance and reinsurance companies collapsed in addition to the devastation of the regions affected. One study surmised that *if* Hurricane Andrew had traveled only 50 miles further north into metropolitan Miami, insured losses would have mounted to over \$50 billion, sufficient to pierce the solvency of the industry as a whole. (Doherty, 1997; Changnon et al., 1997)

Two years later California fell victim to the Northridge earthquake, producing \$12.5 billion in insured losses. One could only imagine Andrew and Northridge occurring in the same year to realize the extent of liability the insurance and reinsurance sector was potentially facing.<sup>4</sup> The new “cognition of catastrophe” (Meszaros, 1997) moved the boundary posts of disaster for underwriters; it was a far cry from two \$7 billion windstorms given in theory just a decade earlier. Table 1 details the recent figures for the costliest loss events from natural perils for the insurance industry (Swiss Re, 2000); most have occurred within the last fifteen years. As is shown in the table, the costliest disasters have been windstorms, and the level of loss was highly dependent on the geographies affected and the level of private protection involved. It is notable that until last year, the Kobe earthquake ranked 9th in this listing of insured losses but ranked. However, Japan relied much more on state support in the event of earthquakes, and did not purchase much private protection. Indeed, Kobe as a loss event for reinsurers was superceded by three windstorms in 1999.

**Table 1: Ten most expensive natural catastrophes for the insurance industry**  
(Sigma/Swiss Re, 2000)

Event	Region	Date	Insured Loss (\$ billion 1999)
Hurricane Andrew	USA	1992	19.060
Northridge Earthquake	USA	1994	14.122
Hurricane Mireille	Japan	1991	6.906
Winter Storm Daria	Europe	1990	5.882
Hurricane Hugo	Puerto Rico	1989	5.664
Winter Storm Lothar	Europe	1999	4.500
Autumn Storm	Europe	1987	4.415
Winter Storm Vivian	Europe	1990	4.088
Hurricane George	USA/Caribbean	1998	3.633
Typhoon Bart	Japan	1999	2.980

<sup>4</sup> Moreover, these insured loss figures are only a fraction of the total economic losses.

The trend towards a new class of catastrophes mounted force in the late 1980s and rose steeply during the 1990s. The concomitant insurance claims explosion is not so much attributable to an increase in natural disasters as such, but in the extent of human development in their geographies of impact. Indeed, societal vulnerability to natural hazards has remarkably increased in terms of both physical and human systems over the past twenty years. Particular geographies, notably in the United States, have experienced rapid increases in vulnerability. These include the coastlines of Florida and California, where population and property values have increased dramatically.

At the same time, catastrophic natural perils (i.e. those that occur infrequently but with severe consequences) do not take priority in settlement and land use decisions. Indeed, areas that have been particularly susceptible to natural perils, such as floodplains or coastal regions have seen considerable migration (Burton, Kates and White, 1993). Not only the population, but also the systems upon which society relies for communication, financial transactions, resource monitoring, energy provision and material production have become increasingly vulnerable to interruption due to their dependence on integrated technology. Such networks could face indeterminable malfunctions from natural perils. Thus, it is not simply a question of compensation of isolated properties, but indeed of the re-establishment of *infrastructures* and of entire geographies – social, political and economic.

The main reasons for the neglect of catastrophic risk in development rest on the convergence of economic incentives and short term timeframes (Mileti, 1997). In order to

bring a greater discussion of the comparison of different temporal and spatial frames of the stakeholders to reinsurance and catastrophe risk, their different perspectives are outlined below. As shown in Table 2, there are varying degrees of involvement and obligation, both temporally and at the level of scale, of participation in the risk market.

**Table 2: Degree of temporal and spatial variability among stakeholders**

Stakeholder	Temporal Perspective	Scale	Awareness of risk markets	Degree of liability
Property Owner	Ownership of Home(s) 3-35 years	Could be dispersed in different locations for different functions (home, business, leisure)	Not aware beyond own insurer	Mortgage availability dependent on home insurance Moral Hazard
Insurer	<ul style="list-style-type: none"> <li>•Yearly contract</li> <li>•Quarterly report</li> <li>•Claims settlement period</li> </ul>	Local / Regional	Aware with respect to own reinsurer(s)	Integrated in Local Economy; Liability for own contracts Moral Hazard
Reinsurer	<ul style="list-style-type: none"> <li>•Yearly contract</li> <li>•Quarterly report</li> <li>•Claims settlement period</li> <li>•Duration of catastrophes</li> </ul>	Regional / Global	Most aware, but at the same time, not as aware of systemic risk management across reinsurance	Liability for insurance and reinsurance losses (retrocession)
Government	<ul style="list-style-type: none"> <li>•Election cycle</li> <li>•Long term institution building (10+ years)</li> </ul>	National, with other hubs operating at regional and local scales	Some awareness of commercial sector; Federal programs provide blanket coverage	Liability for post disaster assistance; Maintenance of infrastructure and inflation control

As shown in the Table, for the individual homeowner or business property owner, catastrophe risk is viewed with respect to temporal and spatial ownership of property.

Therefore, if ownership is no more than a few years, then the low probability of catastrophe risk is not viewed as a competing priority, unless mandated by some legal or financial mechanism. For example, insurance is often a prerequisite to a home mortgage in a few countries, therefore the provision of insurance affects a number of decisions on different timescales. On the other hand, property owner awareness of the extent and character of risk transfer beyond the insurer is minimal.

The view of the insurer, while greater than the homeowner, remains local. The insurer realizes the risk - return of offering catastrophe coverage, and seeks to retain premia while transferring liability to reinsurers worldwide. The local insurer does not have the flexibility of the reinsurer to enter and exit particular geographies. Thus insurers critically depend on reinsurers to provide the financial capacity to accommodate catastrophe risk liabilities from their local clients. Insurance contracts are usually active for one year, but at the same time the insurer must submit quarterly returns to shareholders.

At the level of reinsurance, a number of perspectives begin to change substantially. The reinsurer is bound by commitments to insurance clients, but also has the flexibility to change the composition of a global portfolio of contracts covering a multitude of risks worldwide. To the reinsurer, catastrophe risk entails different degrees of involvement in different layers of the risk liability. Reinsurers also purchase reinsurance, in a process of ever greater levels of risk splintering known as retrocession. Within the retrocessional markets, international capital is one of the driving features of decision behavior. As such, the reinsurer operates in a much more competitive and fluid environment than the primary

insurer, and is greatly affected by changing capital conditions of market capacity to assume risks. Finally, although reinsurers are most aware of the character and nature of the global risk market, there is also an absence of systemic risk monitoring in the spreading of risk, an item to be explored in further chapters.

The government perspective contains a greater temporal and spatial purview, since the state provides a matrix of incentives through regulation and governance. The bureaucracy of state agencies at a number of regional and national scales is also more stable than the volatility and competition of the market. On the other hand, state framing of the catastrophe issue as a non priority can result in unanticipated effects, if land use and governance issues are not integrated. Indeed, in such cases, the government's scope could be reduced to ex post disaster relief. One example is the US national flood insurance program. It encouraged further settlement in flood plains, leading to a trend of greater losses which the government first attempted to correct with purely technical measures during the 1930s and 40s (Burton, Kates and White, 1993). Much more recently, the U.S. Federal Emergency Management Agency (FEMA) initiated a program of urban preparedness for US cities (Project Impact) through greater attention to and enforcement of building codes.

As outlined above, catastrophe risk is reflected in different temporal and spatial dimensions, depending on the level and objectives of participation in the risk market. The homeowner seeks a medium to long term insurance guarantee. The insurance and reinsurance markets, however, operate on yearly cycles (with up to five years foresight at

most), sensitive to losses in particular regions. Property owners might find after a loss that the subsequent rise in rates excludes them, or that their insurer has become bankrupt and coverage is being withdrawn from the market for their region. Indeed, the long term and the short term also conflict in quarterly statements to shareholders, the demands of return to capital, and the time required for claims settlements long after the event has occurred. The government also must consider the insurance market cycle, in terms of long term governance of land use patterns and regulation of the insurance market.

### **Catastrophe Risk and the Risk Society**

As catastrophic risk from natural hazards is a combination of the external peril and the threshold vulnerability of the existing human infrastructure in the areas concerned (Smith, 1996; Mileti, 1997; Blaikie et al., 1994), the danger cannot be isolated from the greater human and physical geography that it affects. As outlined above, this context includes market and state incentives rewarding short term gain over long term spatially integrated planning, eroding the vision of future preparedness. Over a number of disasters, such a short term risk management perspective to catastrophes has resulted in a reactive policy. In an analogy to pollution, such measures are “end of pipe” in terms of ex post compensation and state funding.

Such risk production is not unsimilar to Ulrich Beck’s vision of technological risk societies (Beck, 1992). At the same time, in the case of natural hazards, descriptors such as “Act of God” reveal a fundamental difference in the public perception and treatment of liability for the cause of the loss of natural disasters vis a vis technological accidents.

Natural disasters may begin to lose some of their “natural” descriptor (arguably a relic of romanticist views of nature) if liability for the severity of some events are linked to human intervention in and modification of the environment (Blakie et al., 1994). Such changes include the diversion of waterways or the felling of forests for agricultural production. It may be more effective for social resiliency and measures of self reliance if the ex ante potential for catastrophic risk is integrated in planning measures to reduce the evolution of social vulnerability.

Insurance, as a legal contract *and* a commodity, is a highly flexible risk management instrument (Ewald, 1991), and as such can incorporate a wide variety of stipulations to apportion compensation to suit a particular impact of a catastrophic event. In this way, commerce can act as a handmaiden to duty, risk can act *as* governance. Commercial imperatives to reduce losses could spur insurers to act as risk management institutions by requiring policy holders to maintain strict building codes as part of the insurance contract.

How can one effect such governance by risk? It would begin with an understanding of how decisions are made in insurance. Theoretically underwriting relies on statistics to form an expectation. Sufficient grouping of independent risks with robust loss histories enables probability based pricing based on the law of large numbers, the mainstay of the insurance epistemology. The law is shorthand for the statistical phenomena that as the number of risk contracts increases (contracts are assumed to be for similar loss contingencies of similar objects and are independent of one another), the *variability* of losses over the sampled population decreases. Therefore, it becomes easier to place a

probability measure on the claims space of a particular book of business. For catastrophe risk, this “statistical projection” becomes problematic for two reasons.

Firstly, catastrophic risk as such (for example, a technological accident, or a natural peril affecting a particular region) does not occur in the same place with substantial repetition to generate historical loss data. This infrequency impedes statistical evaluation of the risk of loss over one year, the underwriter’s main avenue of expectation. An earthquake that has not occurred for a century simply becomes a 1/100 risk in any given year, for example. Secondly, catastrophe risk from natural perils affects all the properties insured in a particular region, making it in fact a “metarisk”, or risk affecting all other risks for the primary insurer. While insurance serves to spread the burden of loss in society by aggregating the premia of many policyholders in the expectation that only a few will have losses exceeding a certain sum, it cannot do so when the contingency is not diversifiable. Moreover, the companies that remain solvent after a natural disaster will be loath to provide insurance in the regions affected.

In managing the claims space, insurers rely on two main factors to varying degrees: financial capacity and quantifiability of the risk (Giarini, 2000). It is the first of these two imperatives that dominate the *reinsurance* market. Indeed, the reinsurance mechanism operates through expectation of the variability, timing and magnitude of financial flows. From such a perspective, catastrophic losses can either be compensated by greater capital input to accommodate the risk, or otherwise “managing” the nature of the risk itself. In a report of the Intergovernmental Panel on Climate Change on catastrophe loss reduction,

the options recommended comprised changes in limiting the direct risk, controlling the damage, transferring the accepted risk, and pricing the product (Watson et al., 1996).

The first option involves selective underwriting and raised or additional deductibles (i.e. those first level payments that remain with the policy holder). Such careful assessments entail costs in hiring specialists to survey and identify the particular risks associated with certain locations. The second response involves ex post release of emergency repair information to claimants and the monitoring of repair work. The third method involves transferring the risk from the primary insurance market to the reinsurance markets. This measure was the preferred, low cost option in the 1980s, during which much of the insured cost of major catastrophes was paid by reinsurers (Dlugolecki, 1992: 397). The last category, pricing the product to accommodate the risk, was deemed the most viable by the IPCC (Dlugolecki et al., 1996). However, both price competition in the insurance sector and the ambiguity involved in estimating the probability of catastrophe risk has undermined its implementation in practice.

As the claims space to catastrophe risk is as yet unknown in the delivery of reinsurance policies, expectation in reinsurance provides a good illustration of the nature of insurance vis à vis other economic sectors. Insurance, unlike the manufacturing sector in which costs are high in the production stages, must look towards the future to determine total costs. Reinsurance competition is especially rife, as barriers to entry are low and there is much activity concentrating on reaping short term returns in particular market conditions. The balance among premium income, brokers' commissions, reinsurance market share

and future liability to the firm represents the crux of the underwriter's dilemma in competitive markets.<sup>5</sup> A high amount of premium garnered relative to the capital base indicates profits to shareholders; however, such a high return may not mark the prudence of a company, since the premia also represents potential for losses in the future, depending on the quality of the risks chosen, or the susceptibility of those risks to a catastrophe. At the same time, insurers and reinsurers must pass rating agency and government standards of solvency in order to achieve a "rating" which reflects their security as protectors and their degree of investment attractiveness.

Other more behavioral considerations are also involved in providing the insurance product, since costs are contingent in part on the actions of the policy holder. While insurance requires a collection of risks for statistical and actuarial treatment of the risk, the insurance policy itself is a contractual arrangement. As subject to the law of contracts, the insurance policy can be undermined by moral hazard, which refers to behavior that either increases the probability of the loss or promotes a lack of preventative measures. Such behavior could range from deliberate damage of property to poor maintenance. Indeed, moral hazard is especially prevalent in catastrophe insurance as opposed to other legal arrangements, since the insurance contract pledges to lessen the financial burden arising from a particular event, but at the same time *does not lessen the probability of the event itself*. Moral hazard reveals that while the insurer is liable for damages as outlined in the contract, it is the policyholder that is partially responsible for the management of loss. This division of risk and responsibility may lead to loss promoting behavior.

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<sup>5</sup> Another measure of the insurance industry's underwriting activities is the combined ratio, or

It could be suggested that the very provision of insurance against natural perils, when not priced to reflect the risk or accompanied by risk management stipulations, encourages moral hazard in catastrophe prone areas (Kunreuther and Roth, 1998; Burton, Kates and White, 1993). One example is the U.S. federal flood insurance scheme, which is frequently credited with laying the risk of loss on the government, but the responsibility for loss with homeowners in developed flood plains. As it is subsidized (and therefore does not reflect the expectation of loss), the flood insurance program does not preclude the further production of social vulnerability in the region (Burton, Kates and White, 1993).

The other prominent dilemma in the management of risk in insurance concerns adverse selection. This descriptor refers to damage - prone risks seeking insurance, while those risks not as susceptible to loss do not. In such cases, the law of large numbers (i.e. the collection of risks) reflects the bad cherries in the risk bowl. Such a collection is a nightmare for the insurer, and it is often only through regulation that such loss prone clients are covered at all (Kunreuther and Roth, 1998).

### **Reinsurance and Catastrophe Risk**

Reinsurers assume critical roles in the catastrophe market by providing the financial capacity that enables primary insurers to offer catastrophe coverage, by decreasing volatility in the insurance market by smoothing returns to insurers, and by undertaking a

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administrative expenses plus losses over total premium received.

risk spreading function across the global reinsurance markets. The discussion of moral hazard and adverse selection between client and insurer also has bearing on the relationship between insurer and reinsurer, as the latter seeks to monitor the underwriting prudence of the insurers under contract. The apportionment of risk and responsibility remains a salient theme at every level of risk transfer in the backbone of the insurance sector, from the primary client to the catastrophe reinsurer at the highest levels. Any changes along the column, especially at the upper reaches, can affect decision making in the entire market, since financial capacity is offered under the assumption that reinsurance can be secured for incoming undesired liabilities. Reinsurance of catastrophe risk thus serves to increase the stability and capacity of the insurer by providing a buffer against claims exceeding a certain level. Reinsurance underwriters, consequently, are faced with the risk management of the dangerous tails of the loss distribution.

It is not likely that the entire property account from the insurer will be transferred, however. Rather, the reinsurance market usually manages catastrophe risk in a piecemeal fashion on an annual basis. The transfer of catastrophe risk is conducted on the template of the catastrophe excess of loss reinsurance contract, whereby the reinsurer assumes liability for claims between a certain tranche from a particular level of catastrophic loss in exchange for a premium from the insurer or reinsurer. The total protection sought is broken into bands of liability. For example, one reinsurance contract could provide coverage to an insurer of \$5 million in excess of \$10 million in total claims from an event. Another contract could provide coverage of \$3 million in excess of \$15 million and so on, until the protection sought is covered. The pricing of these contracts is

theoretically dependent upon the probability of the original risk exceeding a certain amount in claims (for example the probability that the event will trigger losses between \$15 million and \$18 million). Thus the pricing of the reinsurance policy relies on the probability distribution of loss potential in the original policy – requiring an evaluation of risk geographies in the particular regions being reinsured. It is critical to note that the risk transfer rarely ends with one reinsurer, more likely being further divided among reinsurers in retrocession. In effect, the catastrophe excess of loss contract separates the total risk exposure of the insurer into tranches, to be priced and sold in the global reinsurance markets. In this way, financial liability for catastrophes is spread spatially and temporally over a number of reinsurance firms worldwide.

In light of the above discussion, it could be said that catastrophe reinsurers operate in the vortex of the economy. Their participation in the risk market provides the security underpinning new economic developments, such as the construction of property, the development of new products, and through their protection of the property insurance sector, the obtaining of a mortgage for homeowners (Kunreuther and Roth, 1998).

However, in supporting in this indirect fashion new developments in catastrophe prone areas in exchange for a flow of premium income over the past decades, reinsurers may have promoted their own current losses. The business faces a paradox - how to achieve premia in a competitive market without promoting vulnerability? The answer relies on which temporal perspective is taken: how long term and integrated are reinsurers' visions of the risk society? In most cases, the yearly insurance cycle and the imperatives of

shareholder return dictate their decision making frameworks and priorities, as indicated in Table 2.

### **Knowledge and the Catastrophe Market**

While capital is certainly a pre-requisite of an reinsurance company, it is the assessment expertise of the underwriter and the types of knowledge that are drawn upon for decision making that bring value to the firm. This knowledge is both formal and tacit, local and global. The tacit knowledge of workplace practices are combined with the formal knowledge of catastrophe models and hazard assessments. At the same time, the tacit must accept the formal, and integrate it into routines of decision making in order for the formal knowledge to have relevance to outcomes. Global knowledge on the other hand serves the reinsurance underwriter in understanding the influences of changes taking place in a number of different economic and political sectors, and their implications for global reinsurance markets.

As a space of expertise, the City of London is a hub of financial knowledge across a range of sectors, the largest being banking and insurance. While the two businesses share the same geographical area, their cultural and organizational practices are strikingly different. Retail bankers in many ways are cautious risk takers, while reinsurers define themselves by taking risks. Retail bankers wish continuous and steadily increasing income, while reinsurers acknowledge the volatility of returns over time. Indeed, the tacit knowledge of these two trading environments has as its emphasis particular risk taking behavior within historically grounded institutions, contracts, and performance indicators. In an interesting

fusion, however, the banking community has become more and more involved in catastrophe risk, and by extension, reinsurance in general through the securitization of risk and by offering options and futures in cat risk. Reinsurers as well have sought banking advice for risk based management of capital. The City as a center of financial knowledge is well poised for this development. The cultural barriers between bankers and reinsurers are receding as alternative risk transfer (ART) proposes its innovative but untested wares to a niche market.

The City enables a high level of expertise to be in constant interaction, in constant confrontation with different ways of knowing. The first involves the *milieu* of reinsurance in the London market and at Lloyd's in the City. The thesis will describe some of these market practices, the acquisition and integration of tacit knowledge, the dynamics of broker relationships, the interpretation of market signals, and the communal market frenzy during the policy renewal seasons. While much of the local knowledge of the London market is shared and obtained through participation in social practices, there is another scale of the local that is differentiated and particular to each underwriter. These are the local conditions germane to each insurance contract. The local of the insured property include physical conditions, but must also be seen within the context of cultural, legal, and socio-economic arrangements. This information is derived from a variety of sources, the most prominent being the broker's file on the client that is discussed with the reinsurance underwriter at the point of negotiating a contract.

These two scales of the local, one scattered across the globe and the other, concentrated in the City, are both linked in the role of the temporal and spatial boundaries of catastrophe risk (or the great expectation of loss). For example, liability for the reinsurance company is compartmentalized according to the type and duration of the catastrophe. The claims space is subject to a temporal and standardized “bubble” in the reinsurance contract.

Knowledge in the catastrophe market was until recently strongly framed by social routines of decision making and organizational traditions. Reinsurance underwriters relied on inductive reasoning from past experience with perils *and* London market practices to serve as a basis for future expectations. Both have undergone significant changes, hastened by the advent of formalized knowledge embedded in information technology. The unanticipated string of losses beginning in the late 1980s, mostly due to catastrophe perils, heralded the beginning of the rush for catastrophe models and a broadly technical approach to catastrophe underwriting. This technology-influenced decision making became more urgent as a group of 8 new reinsurance companies, specializing in catastrophe reinsurance, was established on the island of Bermuda in 1992. They entered the global market just as London underwent a severe capital drain after Hurricane Andrew.

The new companies set themselves the task of taking market share and of displaying credentials of scientific decision support. Market experience, capital, relationships and the tacit knowledge behind the underwriter’s pen were no longer deemed sufficient for the “flight to quality” by many clients. As a response, reinsurers demanded greater

information and bookkeeping from their insurance clients, since the models themselves required greater data quantity and quality. This search for formalized models in decision making led to a rapid learning process throughout the industry. However, the foundation for reinsurance expertise remains not the formalized outputs of computers, but rather the intangible milieu of the London market.

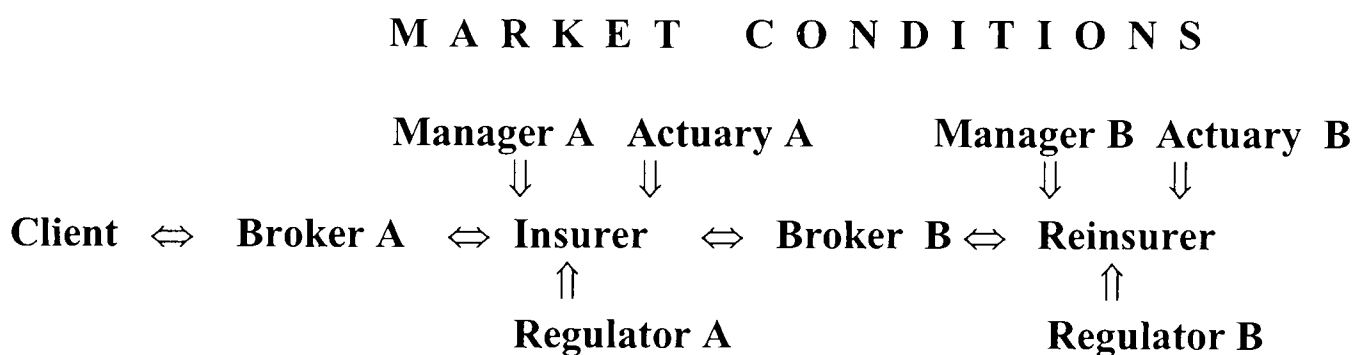
### **Underwriting and Catastrophe Risk: Judgment and Information**

While insurance has been discussed in this introductory chapter, underwriting – the focus of the study - has not. Underwriting is from its origins a pledge of participation, a signing onto a venture. It remains the central activity in insurance, and in an insurance market organization such as Lloyd’s of London, underwriting is the literal commitment to a percentage of the risk being taken around on a “slip.” As it is the insurance underwriter who is responsible for the acceptance of the risk in the marketplace, it is important to investigate the nature of the decision making and judgment of insurance underwriters in order to understand the movements of the insurance industry with regard to catastrophe perils.

To provide a context for judgment and decision making, a schematic of information flow in the insurance industry is shown below in Figure 1. It displays the role of the actuary in providing a statistical estimate of the risk where possible, the manager in supplying firm level goals such as market share and return, and the regulator in setting solvency requirements for the firm. Often, information on a specific risk is transmitted through a broker, who acts as an intermediary between the client and the insurer(s), and also

between the insurer and reinsurer(s). Thus, while the underwriter is responsible for asking the appropriate questions of the broker on the nature of the risk, it is the broker who transmits the information from the client. Underwriters are reluctant to support risks for which information is missing, or which, as the weight of evidence is gathered, the probability of either extreme loss or multiple loss is judged considerable. On the other hand, they also base their judgment of a risk on the credibility of the broker, and the relationship with the broker over time, in different market conditions.

**Figure 1: Simplified representation of information flow in the insurance industry** (modified from Kunreuther, Hogarth, and Meszaros, 1993: 75)



It is important to note that once the risk is transferred to the reinsurer(s), much of the original information on the physical risk has gone through several interpretations, evaluations, and different priority considerations. The main underwriting decisions should be seen in that context. These are listed below.

- Do I accept this risk?
- At what price?
- In what kind of portfolio of risks?
- Do I seek reinsurance for the risk?

Many of these decisions, while shown in this order, are interrelated in the mind of the underwriter. Acceptance of a risk depends on the price the market will bear, the type of

portfolio the underwriter seeks, and the cost of reinsurance. If the insurance underwriter can rely on reinsurance to cover the ambiguous and costliest loss contingencies, then acceptance of the original risk becomes easier. On the other hand, this alternative may promote moral hazard between the insurer and reinsurer. If reinsurance encourages acceptance of poor risks at the primary level, then the reinsurer will be liable for the poor decisions of their clients. Indeed, reinsurers are wary of providing catastrophe coverage if it is thought to subsidize the profit of the primary insurer. As mentioned earlier, this problem is parallel to one at the primary insurance level, where the insurance provided should not lead to relaxed incentives to maintain building standards, for example. Insurers are also wary of adverse selection as they build a portfolio of risks; for example they prefer not to underwrite in hazard prone areas. Reinsurers, on their part, wish to avoid those companies that use reinsurance to compensate for poor company practices. Coverage is ideally intended for loss contingencies for which suitable ex ante precautions have been taken.

Taking these main underwriting decisions, the context of information flow, and concerns about market relations into account, the individual underwriter seeks a range of facts. Studies have shown that at the level of the insurer, the nature of the peril and the vulnerability of the property is more of a concern than at the level of the reinsurer, for whom the risk market and measures of insurer performance are of primary importance (Tiedemann, 1997, Booth, 1997).

In both cases, the information the underwriter seeks serves inductive reasoning, based either on knowledge of the peril or past performance of the client company. As more information is presented on a particular feature of the risk assessment, such as the causal connection between an indicator such as loss experience details and the risk management practices of the insurance company, the underwriter adds “weight” to an argument of risk acceptance and if so, at which price. Indeed, it is the causal framework of the underwriter with respect to the peril, the vulnerability of the risk, and the risk market will influence whether or not to underwrite the risk and if so, to what extent.

## **Conclusion**

Catastrophe risk, as the crossing of particular thresholds of experience, is a challenge for reinsurance underwriters. The balancing of risk - premium and risk - liability is critical for the very survival of the company. At the same time, the risk of and responsibility for catastrophes are spread among a number of parties: homeowners, state regulators, insurers, and reinsurers. Their differing temporal and spatial priorities may conflict in risk governance mechanisms. The increasing vulnerability to catastrophes, another symptom of Beck’s risk society, urgently requires coordinated catastrophe mitigation. In such measures, moral hazard (the dividing of risk and responsibility) and adverse selection must be taken into account.

The provision of reinsurance both helps and hinders catastrophe protection. The reinsurance sector supports catastrophe coverage but at the same time has been severely damaged by catastrophe liabilities over the last decade. The problems mostly involve the

inability to produce a probability estimate for catastrophes from sparse historical data, and the increased exposure to catastrophes from broader coverage in reinsurance contracts. At the same time, reinsurers enable insurers to provide catastrophe coverage to their clients, thus in some cases abetting development in hazard - prone areas.

Underwriters gain knowledge from a variety of scales, in the local of the reinsurance market and the global of different risk contract origins. The risk market requires the transferal and evaluation of expectation, assessment and decision making. What is the role of probability in defining the thresholds of risk and uncertainty? The next chapter discusses the theoretical risk literature and delves into the nature of probability.

## **CHAPTER 2**

### **Risk and Uncertainty: The Role of Probability and Causality**

## **Introduction**

The previous chapter laid out the context for catastrophe risk, reinsurance, and societal implications. This chapter takes a step back to outline conceptions of risk in several different literatures. Based on different philosophical approaches, risk can be seen as measurable, immutable, or based on social construction. One dominant approach has been to use probability as an anchor for risk. Frank Knight founded the conception of risk in the economic decision making literature by employing frequency probability as a wedge between risk and uncertainty. At the same time, John Maynard Keynes regards decision making as reasoning and argumentation, and employs probability as degree of belief. The two frameworks are complementary, since probability is historically derived from a conceptual bifurcation, as frequency in a series and as degree of belief. A short overview of the history of probability in the academic literature is given to elucidate this dual status. The chapter also compares Knight and Keynes and argues that both approaches neglect causality in the formation of expectation. An outline of several main perspectives to causality is given, with an aim to draw upon this base to ponder the gap in risk decision making. The discussion then provides a framework of risk decision making with a causal component – that of Mackie’s causal field within Keynes’ weight of argument. The chapter thus provides the first building block towards a geography of risk, by suggesting that risk and uncertainty need reference to a causal framework.

Risk, as the combination of opportunity and danger, is an inevitable quality of human endeavour. In some respects, it is shaped by humans through actions, expectations, and beliefs. In this way, risk is a metaphysic (Ewald, 1991); in other respects, it is not

controllable, but rather perceived as fortuna, or chance. Catastrophic risk from natural perils combines the two perspectives. On the one hand there is the danger of the physical hazard, on the other hand the danger resides in the beliefs and routines of society. The academic literature mirrors this diversity. As such, risk is a multifaceted construction, and certainly not reducible to only a treatment of probability and consequences. The aim of disciplines has been to conceptualise risk, to encase it within boundaries, in order to manage it. Indeed, it is the management of adverse consequences that provide the teleological appeal to many perspectives of the risk literature. Another strand has been philosophically and socially situated: how are expectations and beliefs of adverse consequences formed? What are the social roles of expertise and authority in their formation? In particular, how is risk expertise to be embedded, when the conventional structures of the risk problem formulation have been debated and their legitimacy as universal representations contested (Krimsky and Golding, 1992; Douglas and Wildavsky, 1982)? Risk as a topic for academics has become the site for cultural expectation to gain voice. Uncertainty, on the other hand, is relatively mute, since it depends upon risk to define it.

### **Risk Conceptions**

The roots of the different conceptions of risk have identifiable epistemological and ontological foundations. These different bases mean that arguments concerning risk could be at cross purposes if proceeding from different premises and indeed, using the same words but with different meanings (Adams, 1995). Moreover, one may share broader conceptions of risk (such as ontology), yet still not find a consensus on the more

specific definition of risk (such as epistemology). An analogy can be taken with painting. There are different schools of painting (such as different schools of risk), all interpreting reality using different conceptualisations, for example, impressionism versus cubism. However, within these schools, there are also variations along a continuum, such as Seurat's pointillism vs. Monet's canvas of blurred images.<sup>6</sup>

One typology of the competing conceptions of risk is as positivist or relativist (Shrader-Frechette, 1991). The former seeks to quantify risk based on a realist epistemology and an ontology that the world can be known through measurement. The latter, on the other hand, contends that risk is formed through personal and institutional epistemologies. There is no universal objective risk definition, and as such risk can only be known through subjective interpretation, of discourse and perceptions (Hajer, 1995).

A related but alternative dichotomy of risk conceptions is as probabilist or contextualist (Thompson and Dean, 1996). The probabilist takes risk as objectively knowable through mathematical expectation within probability theory. Probability as the anchor of risk in the economic literature is the basis for a class of decision making. Indeed, probabilism has contributed to economic decision theory, such as Frank Ramsey's (1926) work on expected value. Milton Friedman and Jeffrey Savage's work into the foundations of statistics define risk as "the function of the probability and utility (or value) of events." (Thompson and Dean, 1996: 367) This definition is very similar to that used in insurance theory - risk is the probability of an event multiplied by the severity of its

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<sup>6</sup> In fact, the schools themselves are not neatly self-contained, but blur at the edges as to accommodate

consequences - the product is the expected value (in mathematical terms). With such a concept in hand, the decision maker can rank and compare the expected values of different outcomes.<sup>7</sup> Friedman and Savage state that “any choice of options with multiple outcomes, each of which can be assigned a conditional probability contingent upon selecting a given option, is made under conditions of risk.” (Thompson and Dean, 1996: 364) Risk decisions thus also serve as a benchmark for the concept of rationality. Such rationality assumes that an isolated decision maker acts to minimise the greatest harm (and maximize expected utility) through an objective characterization of choice with full information on probabilities and outcomes of various options.

The contextualist perspective does not view probability as the fundamental basis with which to assess risk, and moreover, no one single attribute can serve this role. The epistemology of the contextualist is to understand the risk context from researching facts about the particular development and definitions used to define the risk reality. The contextualist sees the situated nature of the risk as most important, i.e. the context which gives rise to situations or decisions determining the particular framing of the risk. The attributes of risk can thus include the scientific, technical, and cultural settings. It is a similar approach to the relativist, but unlike relativism, contextualism does not make claims concerning the legitimacy of scientific knowledge or the absence of an external reality of risk beyond mental constructs. The contextualist can be said, therefore, to regard risk not with a relativist ontology in which standard objectivity does not exist, but

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creative transitions.

<sup>7</sup> This framework begs the question how the probability is calculated and the conceptual and ontological bases for this calculation.

rather that reality is both objective and subjective,<sup>8</sup> depending on the epistemologies brought to bear and the context of the investigation. For example the version of reality of a physicist and an economist are both valid, but derive from different perspectives. This view contrasts with positivism, which claims a measurable universal objective reality as its ontology.

### **The Sociology of Risk**

Studies of risk have been greatly influenced by the sociological literature. Notably sociologists Ulrich Beck (1992, 1995, 1996) and Anthony Giddens (1984, 1990) describe a late modernity embracing the future with a lack of caution and foresight, bedazzled by the promises of science and technology. For Beck, risk implies unsuspected danger (negative consequences), the institutional knowledge underpinnings of which underlie the reflexivity that characterises the current age. In Beck's vision, society is not characterised by systems to distribute wealth as in the era of the industrial revolution, but rather arrangements to distribute risk. Beck states (1996, 28)

“The transition from the industrial to the risk epoch of modernity occurs *unintentionally, unseen, compulsively*, in the course of a dynamic of modernisation which has made itself autonomous, on the pattern of *latent side-effects*... 'reflexive modernisation' means self-confrontation with the consequences of risk society which cannot (adequately) be addressed and overcome in the system of industrial society (that is, measured by industrial society's own institutionalised standards).”

This reflexivity refers to the continually shifting bases of our understanding of the propagation of risks within society, the revaluation of the context of past measures, and the epistemological validity of the sciences to provide authoritative expertise on policy

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<sup>8</sup> It is important to note that this “element identification” is not subject to the same scrutiny as would have a

matters. Beck's concern, however, transcends the epistemological into the ontological: can the consequences of future risks be known? Beck implies through his concern with both knowledge production and democracy that a lack of precautionary, democratic control over social risk production will result in catastrophe. He stresses that the nature of catastrophic risk is related to the framework in which political decision making, technology interests and research agendas are re-instituted through power relations.<sup>9</sup> Coming from the German tradition of corporatist institutional management, systematic risk assessments, and high levels of insurance protection, it is not surprising that Beck in fact describes the risk society within the frame of insurability and the extreme case of catastrophic risk. Moreover, for catastrophic risk, the institutional rationality of probability does not provide a sufficient guide for decision making. Beck states (1992: 37)

“The impossibility or at least the sheer insurmountability of the barriers to agreement [among different stakeholders] arise from the perception and assessment of catastrophes. Here the yardstick of the ‘rationality’ of the *probability of occurrence* is ineffective.” (my emphasis)

For Giddens, sociological risk analysis is bound up in the “double hermeneutic” of the discipline of sociology itself. He describes the study of society as spiraling “in and out of the universe of social life, reconstructing both itself and that universe as an integral part of that process. Sociology, unlike natural sciences, does not develop cumulative knowledge.” (Giddens, 1990) Sociological inquiry is thus bound to interpretation and the inability to know reality *as it is* as opposed to reality as seen through the lens of the

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relativist, but rather taken literally.

observer. Giddens further enjoins sociology as a discipline devoted to studying how social systems “bind” time and space, and how modern institutions become “situated” therein. He proposes the term “structuration” to describe the mutual influences of individual actions and the organizational and institutional structures of their enactments (Giddens, 1984). The risk problematic is thus framed within the larger ongoing routines of society. Giddens proceeds to develop the dialectic between public trust and expert systems, a theme common to Beck. Trust is linked to experience of reliance, “contingency reliability in the face of contingent outcomes whether concerning actions of individuals or the operation of systems.” (Giddens, 1990: 33). Trust in external webs of interaction occur at the intersection of culturally influenced support systems and accepted notions of individual reliance (either through personal measures, or insurance policies).

According to Giddens, the social concept of risk replaces what was previously thought as *fortuna* or chance (1990, 30) Fortuna characterizes those cases whereby more knowledge does not necessarily give greater control over the course of events. Furthermore, he argues that events and circumstances are experienced differently whether they are thought to arise from risk or from fortuna. Giddens remarks “Precisely where risks are greatest, fortuna tends to return.” (1990, 111) In other words, catastrophes are more likely to be viewed as chance events, rather than as situated in the realm of human practices and knowledge production. This characterization of catastrophes as external events, to be controlled through technology and engineering projects, may be one of the reasons for the

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<sup>9</sup> This concern could be compared to that at the start of the industrial revolution in the suspicion and contempt for the machines which were displacing human labour.

focus in the modern era on the *cause* of the disaster, instead of its incipient *conditions* in human practices.

Another well represented perspective in the sociological literature is of social constructivism, which proposes that risks are mental constructs, expressions of preferred future scenarios for society (Szerszynski, Lash and Wynne, 1996). In discourses between different sectors of society, decision making perspectives are shaped by cultural politics and institutional frameworks (Hajer, 1995). One point of tension between the realist and social constructivist literatures is their respective views of environmental reality.

According to pure constructivists, the problem of chemical pollution in a lake only exists as it appears in discourses and is shaped by mental and social environments. The existence of the problem is a question of interpretation by those who formulate and participate in the discourses.

Within another domain of literatures, the combination of the valuation of risks (as founded upon probability and consequences) and the human penchant for risk taking has motivated a field of inquiry within psychology (Kahneman and Tversky, 1979) as will be discussed in more detail in the thesis. Such research has also created fusions between the individual psychology of risk perception (Slovic, Fischhoff, Lichtenstein, 1980; Adams, 1995) and its social context (Margolis, 1996; Kasperson et al., in Krinsky and Golding, 1992) in a parallel to Giddens' structuration (Giddens, 1984). For these literatures, risk is the expectation of negative consequences, but how the perceived likelihood of those

outcomes affects present decision making for policy or consumer choice depends on a number of factors, cognitive and perceptive.

### **Insurance and Catastrophes**

The mechanisms of insurance to build upon base classes of risks in effect classifies reality in time and space into risk categories of probabilistic order to create metaphysical capital - capital to accommodate beliefs about the future (both on the part of the insurer as well as the policyholder). There is on the one hand an aspect of gambling amidst fortuna or chance. On the other hand there is also social trust in the insurance system as accommodating the greatest risks, based on the capital capacity of the industry as a whole. (1) below encapsulates the meaning of risk to an insurer as a probability distribution over possible loss values. Thus, risk for the insurer is the expected future value of a certain outcome, expressed in monetary units.

$$\text{Risk} = \text{Probability} * \text{Consequence (distribution of loss levels)} \quad (1)$$

It is clear why both components of (1) are essential information for the insurance underwriter. The first part, probability, denotes the frequency with which the event is expected to occur, while consequence indicates the amount of insured damage to be expected. Taken together, they form the theoretical basis for insurance pricing. Both the first and second terms can be derived from a statistical analysis of historical data on recorded occurrences of events and their consequences. The risk product is a number, usually indicating expected losses, which can be compared and ranked with other risks, allowing the rational choice among a diversity of risks to be possible. However, in the

case of catastrophic risk the formula might be changed to (2) below (representing in effect the “tail” of the probability distribution of (1) ):

$$\text{Catastrophic Risk} = \text{Probability Substitute} * \text{Consequence} \quad (2)$$

The second part of the product, the insured consequences, can usually be estimated as the total liability exposure of the insured values. However, for much catastrophe risk, such as that from an earthquake or a hurricane following a particular path, actual historical loss data are usually too sparse (or is non existent) to provide a basis for statistical analysis as an entry to expectation. For cases involving catastrophes, probability substitutes are used, based on both inductive enumeration and analogy. It is at this point that a discussion of the nature of probability might elucidate the true nature of (2) and the appropriateness of a probability substitute in the context of catastrophes. In so doing I argue that in the case of catastrophes, a distinction between risk and uncertainty might prove more useful than a probabilist stance, however accommodated by a probability substitute. In other words, one may find a conceptualisation of the problem of catastrophe risk to be more complex than the risk definition provided by (1).

### **The Dual Nature of Probability**

“The probability function contains the objective element of tendency and the subjective element of incomplete knowledge.”<sup>10</sup> - Heisenberg

“Quod facile est in re, id probabile est in mente.”<sup>11</sup> - Leibniz

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<sup>10</sup> Ian Hacking (1975) *The Emergence of Probability* Cambridge: Cambridge University Press, 148.

<sup>11</sup> Hacking (1975), 128. This citation from Leibniz is taken to mean “Our judgement of probability ‘in the mind’ is proportional to what we believe to be the facility or propensity in things.” Probability is degree of certainty.

It may be said that the conception of probability taken from Heisenberg and Leibniz most comprehensively describes its essentially dual nature: that of combining knowledge of the past with an indication of the future. At the same time, there is another duality to probability, directly related to the historical development of the concept itself and for which ends the concept was tailored. A brief excursion into the history of ideas will outline this development and in so doing will provide the background to the relevance of probability to catastrophic risk.

Games of chance are documented throughout history in countries all over the world, and in many cultures there exists a framework for the calculation of odds. However, the formal conceptions of probability existing in the contemporary academic literature owe their roots to converging intellectual debate in Europe during a short time period around the 1660s (Hacking, 1975, 1990). Prior to this period, the common conception of the “probable” was linked to approbation by those in authority and the weight of opinion (opinion). As such, “the probable” was not conjoined with knowledge or evidence, but rather the testimony of certain respected posts in society, especially those concerned with the maintenance of social codes, such as judges.<sup>12</sup> Institutional authority as the writ of probability was strengthened by the absence of a role for evidence in providing opinion. According to Hacking (1975) there existed at the time no general concept linking knowledge of the present state of the world with an indication of the contingent possible

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<sup>12</sup> It is important to note the hierarchy existing at the time between the high sciences, which held that knowledge had to be demonstrable (such as astronomy and mechanics) and the low sciences (such as alchemy or medicine) which was dependent on opinion.

futures. This impasse was to be broken with the increasing dependence on verifiable “signs” as external confirmation of probability.

These signs could be reliable in two main ways: by their *frequency* of occurrence or by their *relevance* as evidence. Thus, two main avenues for probability to develop were opened: one as evidence provided by frequency in a series and one as evidence of the truth of a proposition. One of the main figures in the development of this dual concept of probability was Leibniz, who in the course of assessing a mathematical scale of proof for the law construed a logic of contingent events in 1665. To Leibniz, degrees of probability were degrees of certainty. In other words, he was concerned with the provability and implications of a theory of chance, rather than with the physical outcome of events.

Huygens used expectation as the foundation of his version of probability in 1657. Jacques Bernoulli, in 1713, published his work on the first limit theorem and thus focused on the notion of probability as frequency in a series. By this time, probability assumed two main forms in the academic discourse: aleatory or *de re* (about things) and epistemic or *de dicto* (about propositions) and contained expectation of the future based on knowledge of the present. The development allowed the foray into the problem of induction by Hume in 1737.

A survey of probability was included in Diderot’s *Encyclopédie* in 1754 in which the importance of “equipossibility” was stressed as the justification of a measurable probability. Equipossibility was one way for the French to try to synthesize the dual concepts of probability (Hacking, 1975). It is interesting to note that Bayes did not

mention equipossibility for probability due to the English attention on probability in the purely aleatory (or frequency) sense. Diderot wrote that equipossibility “is to be employed when we suppose the several cases to be equally possible, and in effect it is only a supposition relative to our bounded knowledge, that we say, for example, that all points on the die can occur equally.” (Hacking, 1975: 129)

### **Risk, Uncertainty and Probability**

Over the subsequent two centuries, the concept of risk as expectation (usually of negative consequences) was refined in mathematical expression and theoretical finesse. Such an approach contributed to the social authority of a technical and engineering basis for the perfection of environmental and social conditions as well as the development of political mathematics, today known as statistics. By the early 1900s, Bachelier in France had published a dissertation on probability and financial mechanisms but there had not been a foray into the concept of risk *qua* capitalism.

Economist and philosopher Frank Knight sought to derive a theoretical foundation for the existence of capitalist institutions (Knight, 1921) and decided to focus on the role of frequency probability as measurable expectation. Towards this end, he presented a dichotomy between states of risk and those of uncertainty depending on their degree of expectation. On the nature of risk and uncertainty, Knight stated (1921, 233),

“The practical difference between the two categories, risk and uncertainty, is that in the former the distribution of the outcome in a group of instances is known (either through calculation *a priori* or from statistics of past experience), while in the case of uncertainty, this is not true, the reason being in general that it is impossible to form a group of instances because the situation dealt with is in a high degree unique.”

Frank Knight was so intrigued by the institutions of the capitalist system and their reliance on expectation that he ventured a definition of risk (as opposed to uncertainty) based on insurability in an emphasis not unsimilar to Ulrich Beck. Risk is insurable while uncertainty is not because for the latter, ‘there is *no valid basis of any kind* for classifying instances.’ (Knight, 1921: 225). This classification of instances, the measurability of expectation, forms the theoretical basis for insurability. At the same time, Keynes observed insurance operations at Lloyd’s operating with minimal expectation, but rather accommodation through capital capacity.<sup>13</sup>

Knight posited that the institutions of the capitalist system are geared to minimise risk, but it is uncertainty that provides the *sine qua non* for their existence; indeed the foundation for profit is uncertainty (1921, 271). Knight also ventured to group cases of uncertainty, such as a manager’s unique decision regarding future production costs in a new market. While he did not describe other methods of measuring uncertainty (if not by

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<sup>13</sup> Keynes (1921, 25) does not exclude insurability from unique events, and his argument is based on observation that insurers do in fact do business in covering such events. It is the aim of this thesis to discover why and how they do so. Keynes states: “...underwriters themselves distinguish between risks which are properly insurable, either because their probability can be estimated between comparatively narrow numerical limits or because it is possible to make a ‘book’ which covers all possibilities, and other risks which cannot be dealt with in this way and which cannot form the basis of a regular business of insurance - although an occasional gamble may be indulged in.”

frequency probability), he offered some characterisation.<sup>14</sup> He contended that “the habit of mind is not only to form an estimate of the situation but also to make a judgement as to its reliability, also on an intuitive basis.” (1974, 17) In this way, Knight reached towards an epistemic appraisal of an indeterminable frequency probability, what some may term a subjective probability (Ramsey, 1926), or a second order probability (Sahlin, 1991). For Knight, probability “enables us to predict what will happen in groups of instances where we find it impossible to derive laws fitting individual cases.” (1921, 314). Meanwhile, uncertainty is that change which comes about not according to a known law (1921, 313).

Knight acknowledged that human decision making often occurs under conditions of uncertainty and that the common route is to follow habits of mind. However, there is no mention of how these habits of mind might be formed. Instead, Knight proposed two methods for managing uncertainty: a diffusion of consequences and coping via the law of large numbers (1921, 239). In such an approach, a number of instances is assumed which can form a “portfolio of events.” It is unclear how a unique situation can form a portfolio of events in which to diffuse the consequences of decisions.

Economist Kenneth Arrow (1974, 18) does not see how this clarification of uncertainty is different from the properties of probability itself and also doubts the value of the law of large numbers as a device to manage uncertainty when conditionality of facts is

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<sup>14</sup> However, according to Houston (1968, 153), it unclear whether for Knight, in indicating that groups of instances are necessary for a measure of uncertainty, whether he is referring to a degree of variation in outcomes or a probability value itself.

introduced (1974, 24). Moreover, it is unclear how groups of uncertainty cases can lead to a diffusion of consequences, when each situation is unique.

Insurance economist Karl Borch (1967, 432) describes Knight's risk in the economic decision sense, as a class of situations involving a choice of mutually exclusive outcomes with a known probability. Within this framework, uncertainty refers to those cases where the outcome probabilities are unknown, but the choices themselves remain known. Borch contends that the Bayesian development of decision theory has made Knight's dichotomy outmoded. Indeed Arrow (1974, 18) wonders whether Knight's uncertainty "estimates" (as opposed to "statistical probabilities") do not actually refer to *a priori* probabilities, a basic component of Bayes theorem. Instead of Knight's estimates, a more fruitful approach to theory building, according to Arrow, would be to build on Knight's uncertainty within statistical inference as in the Neyman-Pearson model.<sup>15</sup>

In focusing on probability as frequency in a series, Knight does not consider the ontology or the epistemology of the search for facts in creating an estimate of a future state. His uncertainty is that change which comes about not according to a known (statistical) law (1921, 313). However, probability has another meaning Knight does not discuss, namely as degree of belief (Keynes, 1921). This alternative meaning may provide a more fruitful

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<sup>15</sup> Neyman-Pearson propose a framework in which hypotheses attached to a particular model are known but there is no attachment of probability as to the hypotheses' truth values. The consequences of the hypotheses are surmised and given probability distributions. The choice then operates under two types of uncertainty: the truth of the hypothesis and the consequences of the hypothesis (the latter is expressible as a probability function). This description, it may be said, follows a meta - theoretical analysis of whether or not a hypothesis is true, and given a true hypothesis, the nature of the probability describing its possible outcomes. The ontology is realist - there is a true hypothesis among the set.

concept for catastrophe risk decision making, as it probes the issues of the *formation* of expectation, not simply its measurement.

### **Keynes and the Weight of Argument**

At the same time Knight published his text, Cambridge economist and mathematician John Maynard Keynes released *A Treatise on Probability*. Keynes' concern was not to expound on the underpinnings of free enterprise or the nature of choice, but rather to provide a logical analysis of human reasoning. The essential foundation of Keynes' theory is that probability is a logical relation, a proposition, based on arguments from premises to conclusions given a group of facts (1921, 97). A logical system of probability provides the scaffolding upon which one converts "vague knowledge into more distinct knowledge."<sup>16</sup> (1921, 53) As such, logic provides a testable framework which allows the rational selection of argument. As with Leibniz, probability in Keynes' 1921 text refers to degrees of certainty, but Keynes distinguished between certainty (within logic) and truth (with regard to an external world). Keynes noted that probability is

"only relative to the knowledge at the time...Our estimate of the probability of an event varies not absolutely with the circumstances which actually affect its occurrence but with our knowledge of those circumstances."

On the other hand, in discussing chance, Keynes made a distinction between subjective and objective chance. Subjective chance required an investigation of knowledge and ignorance in a covering law approach, while objective chance (i.e. fortuna) can not

provide any law since no law is knowable (due to each case being unique). (1921, 288)

This treatment of calculable and incalculable chance is similar to Knight's dichotomy between risk and uncertainty. Keynes took a step back from Knight, though, to admonish that one can only know if one has a random sample when knowledge is nearly complete.

"Whether or not a given instance is taken at random, depends, therefore, upon what generalisation is in question," he stated (1921, 292). This is a critical stance with

significant relevance for a conception of decision making under catastrophic risk. The

implications are that randomness must have a reference to (frequency) probability,

otherwise it is meaningless. For example, how is one to know whether the natural

catastrophes one is witnessing are indeed chance, or subject to a greater statistical trend?

Keynes' epistemological approach to the subject of probability allows a broader inclusion

of elements contributing to a weight of argument than Knight's swathes of risk and

uncertainty, although the latter certainly provides a framework for comparison of

different situations, leading to a characterisation of cases much like in the insurance

industry.<sup>17</sup>

Keynes further developed his epistemic framework by counterbalancing the concept of

"weight" with that of probability. The weight of an argument is the sum of favourable

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<sup>16</sup> Keynes stated: "The object of a logical system of probability is to enable us to know the relations, which cannot be easily perceived, by means of other relations which we can recognize more distinctly - to convert, in fact, vague knowledge into more distinct knowledge." (1921, 53)

<sup>17</sup> Although Keynes discussed statistical or frequency probability in his work, it is not the basis of his analysis. He admonished that within the quantitative properties of probability, one can only compare probabilities which are in the same series. His brief discussion of statistics emphasised the lacking treatment of the particular case. He also mentions two cases for a unknown probability - the first case being similar to Knight's uncertainty (an unknowable probability), and the second case referring to unknown probability, but knowable in principle (except for lack of skill, etc.). As Keynes was not concerned with risk as such, his treatment of risk is casually sketched as the mathematical expectation of adverse consequences.

and unfavourable evidence while probability measures the difference, thereby pointing to a particular conclusion (1921, 77). Another interpretation of the “weight” of an argument is the reliability of its probability. Keynes remarked in the *Treatise* (1921)

“As the relevant evidence at our disposal increases, the magnitude of the probability of the argument may either decrease or increase, according as the new knowledge strengthens the unfavourable or the favourable evidence; but *something* seems to have increased in either case - we have a more substantial basis upon which to rest our conclusion.”

The most important formation of argument for Keynes rests on the methods, as he called them, of Induction and Analogy (1921, 217). Keynes’ elaboration of induction is divided into pure induction, or arguments based on the number of instances, and a combination of pure induction with analogy (1921, 275). In his explanation of the correspondence of induction and analogy, Keynes declared a connection to causality (1921, 222)

“All kinds of reasoning from causes or effects are founded on two particulars, viz. the constant conjunction of any two objects in all past experience and the resemblance of a present object to any of them. Without some degree of resemblance, as well as union, ‘tis impossible there can be any reasoning.”

The above discussion of Knight and Keynes points to a distinctive difference in the authors’ approaches to expectation and probability. At the same time, they were motivated by different imperatives in writing their works. For Knight, it was an attempt to explain, within a framework of risk and uncertainty, the organisation of the capitalist work environment, both at the micro level of decision making and the macro level of firm and institutional behaviour. Keynes, on the other hand, regards the problem of formalising a rational method of determining degrees of belief and reasoning as his main task. Both are concerned with probability. Knight uses the concept of probability in the

aleatory and a priori sense to fashion a wedge between risk and uncertainty. Keynes uses probability in a degree of belief sense and as a directional indicator of the weight of argument. From the discussion so far in this chapter, a tripartite of probability conceptions can be distinguished (Adams, 1995: 26).

- judgments of a priori probability (as used in aleatory risk and catastrophe risk)
- estimates of actual frequency (in a series as in Knight, 1921)
- judgements of credibility in a logical sense (as in Keynes, 1921)

So far in this chapter, I have argued for a better understanding of catastrophe risk by taking a philosophical approach to the meanings of probability and risk. However, it is increasingly clear that another factor is missing in the insurer's view of catastrophes. This is the uncertainty which probability as a figure cannot capture. The chapter has brought to the fore the judgmental and frequency treatments of probability, and the possibility for a judgmental probability in catastrophe reinsurance expectation. The nature of uncertainty as related to assessment will be the topic of the next section. As one catastrophic risk consultant described the world of insurance "Uncertainty plagues our business."<sup>18</sup>

## **Uncertainty**

"What I hold fast to is not *one* proposition but a nest of propositions."<sup>19</sup>

An appropriate starting point for a discussion of uncertainty is a discussion of epistemology, ontology and framing. It may be argued that it is a lack of knowledge within a known nexus (ontology) of knowledge frameworks (epistemology) that generates

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<sup>18</sup> Wharton Conference, Dennis Kuzak, EQE International. There is the argument that risk, a calculable probability, provides them with a business, but uncertainty provides them with a profit (Casti, 1998).

<sup>19</sup> Ludwig Wittgenstein (1969), 30e.

gaps of uncertainty. One knows what one doesn't know with reference to a particular framework. It is important, therefore, to distinguish uncertainty, which is still a certain kind of knowledge, from ignorance, which is defined by a lack of knowledge.<sup>20</sup>

Indeed, uncertainty cannot be studied without reference to the reasons for its emergence. As Keynes stated, one cannot know if a sample is taken randomly unless one has complete knowledge. It can also be said that the generalisation of data can frame the sampling taken and may influence whether or not a given instance is random. This reflexivity and relativity of knowledge is an indicator of its contextual influence. The approach contrasts with a positivist epistemology, which downplays ignorance and seeks to overcome uncertainty with more refined methodologies; in other words, the facts are knowable, but the tools are blunt.

There have been several forays into uncertainty and knowledge. Keynes' concept of weight is one approach. Philosopher Nils-Eric Sahlin refers to uncertainty as "epistemic risk" the risk of not knowing, or not knowing enough. (Sahlin and Persson, 1994, 38)

More specifically, epistemic risk is related to the (Sahlin and Persson, 1994, 40)

"flaws in the robustness of our knowledge, in our judgement base... We know very little about what we know, but more important we do not know what we do not know. To make decisions or to give recommendations on the basis of a brittle state of knowledge means that one exposes oneself to an epistemic risk."

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<sup>20</sup> A contextualist would argue that the knowledge of the issue under study is formed by the social, political, and epistemic context of its emergence: this is a more socialised account of knowledge frameworks.

Sahlin also proposes a way to characterize uncertainty in an estimate as a second order probability qua degree of belief, over a first order frequency probability (Sahlin, 1993). The de re instances are scrutinized with respect to the de dicto. For example, if one believes that there is a 32% chance of rain, then in Sahlin's method one can "calibrate" this belief with a confidence level of 87% or a second order probability. Such an approach has been referred to as the possibility of the probability (Hacking, 1975). This thesis argues that a more contextualist and causal approach would enrich the discussion of epistemic risk than a second order probability. Sahlin, perhaps, is trying to solve the problem of uncertainty and ignorance at the same time.

This evaluation of uncertainty as linked to knowledge may clarify the possible frameworks used by catastrophic risk underwriters. Indeed, Keynes in a 1937 article in the *Quarterly Journal of Economics* distinguished between the uncertainty involved in games of chance and that uncertainty associated with an open system of future possibilities, such as a political crisis erupting in a particular region. While reinsurance underwriters view catastrophes as a collection of risks (or expectations of future claims space), they also must cope with uncertainty and ignorance of their underwriting environment, as they make decisions based on a combination of constructed evidence and causal weight.

In the case of catastrophic risk, there exists a knowledge framework represented by the epistemic tools of the underwriter, the active knowledge the underwriter seeks on a routine basis, and the manner in which the knowledge is fashioned to produce or justify a

particular judgement. The potential for surprise (as in catastrophes) increases when a framework of causality and expectation, *de dicto*, does not correspond to the *de re* observation. In order to realise the conditions of one's surprise one must start with a re-evaluation of one's epistemology and how the production of knowledge is framed by assumed causal models and particular ontology. As catastrophes are difficult to estimate using frequency probability, it is all the more essential to uncover the mode of one's abstractions. In this manner, one may avoid the pitfall referred to by philosopher Alfred North Whitehead as the fallacy of misplaced concreteness (Adams, 1995).

In the next section, there is a return to Keynes' weight of argument in order to provide an account of assessment as weight 1 or weight 2. These different conceptions are reassessed with regard to Keynes' logical approach and Ramsey's critique. This discussion, of the distinction between the two different weights of argument, is followed by a treatment of causality, and how a framework of decision making combining Keynes' weight of argument and a particular interpretation of causality can be formed.

### **Weight (1) and Weight (2)**

According to Runde (1990), Keynes described two different concepts of "weight" in the *Treatise on Probability*. In the beginning of the work, Keynes referred to the weight as the amount of relevant evidence upon which to base a conclusion. Two arguments can thus be rationally compared, with the indicators being the "greater substantial basis upon which to rest our conclusion." (weight 1) (Keynes, from Runde, 1990). However, in Chapter 6 of the *Treatise* weight is regarded as the balance of the "absolute amounts of

relative knowledge and relevant ignorance on which a probability is based.” Keynes remarked on weight 2 below (Keynes, from Runde, 1990).

“The magnitude of the probability of an argument...depends upon a balance between what may be termed the favourable and the unfavourable evidence; a new piece of evidence which leaves the balance unchanged, also leaves the probability of the argument unchanged. But it seems that there may be another respect in which some kind of quantitative comparison between arguments is possible. This comparison turns upon a balance, not between favourable and unfavourable evidence, but between the *absolute* amounts of relevant knowledge and relevant ignorance respectively.”

Keynes described weight 2 in terms of the judgement of the balance of evidence with respect to its context in a particular epistemology (within a discipline) or ontology (within a search for information and closure) of facts in general. In this respect, Keynes referred to weight as the *degree of completeness* of information on which the probability is based. For a greater understanding of the differences between these two weights of argument, it is useful to introduce several analytical definitions. Keynes’ notation for probability is shown below in (3), as the logical relation between a conclusion and relevant evidence.

$$x / h = p \tag{3}$$

x denotes relevant evidence, h is the body of knowledge, and p is the probability of the argument.

Runde (1990) offers the following functional representation for weight 1 ( $W_1$ ) as expressing the relevance of information:

$$W_1 (x/h) = K_r / I_r \tag{4}$$

where relevant knowledge is represented by  $K_r$  and relevant ignorance by  $I_r$ .<sup>21</sup>

Runde then proposes an expression for the degree of completeness of information on which a probability is based, i.e. weight 2 ( $W_2$ ):

$$W_2(x/h) = K_r / (K_r + I_r), \text{ reducing to } 1/(w + 1) \text{ where } w = I_r / K_r \quad (5)$$

Both concepts of weight use the term relevant ignorance, which could be construed in a number of ways. It is often a practical concern to be able to identify factors of which one is ignorant, but “which are relevant to the probability estimate.” In this sense, Runde refers to knowing what one does not know, which in many epistemic frameworks represents uncertainty. Runde’s meaning of relevant *ignorance* is illustrated with an example from weather forecasting (Runde, 1990).

“Consider, for example, the proposition  $r$  that it will rain two days hence. We are nevertheless aware of the possibility, in these situations, that better data may be available, or that it may have been an apprentice weatherperson who has been making the reports in recent weeks. And by the same token, we are aware that there are usually relevant factors that we have omitted altogether. It is in these senses, I maintain, that we may speak of ‘relevant ignorance.’”

Keynes’ own description of relevant ignorance places greater emphasis on knowledge frameworks. Keynes stated (Runde, 1990),

“...I assume, however, that just as our knowledge of the evidence that enters into the premises of an argument depends on our individual circumstances, so does our ignorance of factors that we might otherwise have considered relevant. What matters is not the level of that ignorance per se, however, *but how this level will be affected with the acquisition of additional information.*” (my emphasis)

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<sup>21</sup> Runde considers Keynes to take “knowledge,” “information,” and “evidence” as synonymous terms.

An illumination appears when the two weights are taken in comparison and the difference provides the link in the decision making framework to be proposed. For weight 1, new evidence “will sometimes decrease the probability of an argument, but it will always increase its weight” (Keynes, *Collected Works VIII: 77*) since weight 1 simply refers to the amount of evidence on which a probability is based. However, Runde maintains that the surprising feature of weight 2 is that the same conclusion need not follow. New evidence, in other words, may lead to a *decrease* in weight, since weight 2 depends on the degree of completeness of the information, in other words, the balance of the absolute amounts of relevant knowledge and relevant ignorance.

Runde explains as follows by referring back to formula (5). If  $I_r$  does not increase by more than  $K_r$ , it is clear that weight 2 will increase with every increase in  $K_r$ . In principle, it is also possible that we may sometimes learn something that leads us to drastically reassess  $I_r$ , to revise it upward by more than any increase in  $K_r$ . When such learning occurs, the additional evidence will lead to a *decrease* in weight.

Although weight *decreasing* with the acquisition of more evidence does not appear in the *Treatise*, Keynes did remark “...we may say that the weight of the probability is increased, as the field of possibility is contracted.” (Keynes, *Collected Works, VIII: 84*) Therefore, Keynes took to eliminating possibilities, of bounding ignorance by the reflection of what can be known, to produce a weight for probability.

The next argument linking weight 2 and the causal field is considered within a discussion of different conceptions of causality. I argue that as the causal field of the possibilities changes, so it is entirely possible for weight 2 to decrease with the *addition* of evidence, since that evidence is no longer related together in the same causal framework. If the causal field of an assessment changes, for example, then weight 2 may be drastically reassessed in light of the new framework of connections and their implications.

An applied example of this framework could refer to the study of tropical cyclone development and propagation, a science that consists of several competing expert opinions (Gray et al., 1998, Henderson-Sellers et al., 1998, Elsner and Kara, 1999.) The weight 2 of argument approach applies here: opinions differ as to whether the predictability behind tropical cyclone propagation derive from barometric pressure or statistical analysis; at the same time, there is a good deal of uncertainty in both theoretical conceptions and empirical measurements. Taking the weight 2 of argument approach, which is a way to approach knowledge claims, the amount of relevant evidence supporting either barometric or statistical prediction of tropical cyclones, both sides compete not only with each other, but against the realm of ignorance of tropical cyclone propagation. As long as the argument can demonstrate that knowledge of tropical cyclones is increasing and is larger than ignorance of the phenomena, the weight 2 of argument becomes stronger. If ignorance grows larger than knowledge due to a myriad of accounts or a lack of accounts, then weight 2 becomes smaller. Suppose that an observation of tropical cyclone development was made that undermined the assumed overall causal framework of tropical cyclone propagation and development – then weight

2 would decrease with the addition of knowledge due to a change in the causal framework of the debate. Two other examples concern whether or not human induced climate change is occurring, and historical “paradigm shifts” in scientific knowledge – such as the revolution of the Earth around the sun.

Before entering a discussion on causality, it is worth mentioning that Keynes’ purely logical account of rational human reasoning met criticism by Cambridge contemporary and mathematician Frank Ramsey. Ramsey criticised Keynes’ use of formal logic as being remote from the nature of human reasoning, the very system under study. Ramsey declared that “human logic” proceeds by subjective probability, not objective probability, and that by such subjective approaches, conclusions may differ per person given the same information set (1926). While Ramsey managed to persuade Keynes that a subjective measure might be more appropriate concerning human decision making, Keynes remained unconvinced that this *subjective* measure could be “rational.” (Bateman, 1987) For Keynes, any subjectivity vitiated rationality. Ramsey, however, felt confident that as long as the system of reasoning remained internally consistent, it could be considered rational. Ramsey went on to create a mathematical foundation for subjective degrees of belief about events, in terms of the subject making a bet, the foundation for subjective expected utility.

Keynes for his part was not pleased with the ascendance of expected utility and subjective expected utility as the method for analyzing economic decision making. In a 1937 article

in the *Quarterly Journal of Economics* Keynes noted (Keynes, collected works XIV: 115),

“The theory we devise in the study of how we behave in the market place should not itself submit to market-place idols [such as the Benthamite calculus]. I accuse the classical economic theory of being itself of these pretty polite techniques which tries to deal with the present by abstracting from the fact that we know very little about the future.”

Keynes thought that the Benthamite route was a deceptive one. This view is understandable, given Keynes’ treatment of the decision making emphasizing the context of the decision maker, the reliability and relativity of knowledge, the effect of different time horizons, and the influence of conventions (Lawson, 1985).

As this chapter will soon present a causal link to Keynes’ weight of argument, it would be useful to describe Keynes’ own perspective on causality in the *Treatise*. Keynes rarely mentioned causality, aside from an explanatory note in the *Treatise* on the link between causality and expectation, mostly to do with causal determinism and covering laws in the natural sciences. Keynes made a distinction between the *causa essendi* of events, or their (objective) true cause, versus the *causa cognoscendi*, or the perceived cause (Vercelli, 1991). He connected this to the discussion of probability by distinguishing what evidence does or does not have relevance for probability, stating:

“We wish to know whether knowledge of one fact throws light *of any kind* upon the likelihood of another. The theory of causality is only important because it is thought that by means of its assumptions light *can* be thrown by the experience of one phenomenon upon the expectation of another.”

Moreover Keynes also remarked that (1921, 306)

“As our knowledge is partial, there is constantly, in our use of the term cause, some reference implied or expressed to a limited body of knowledge.”

## **A Select Overview of Conceptions of Causality**

In this section a brief selection of several different conceptions of causality in the Anglo-American literature (with a sprinkling of Kant) is provided. The perspectives suggest the diversity in approaches to causality - as in a logical framework, a psychological schema, an economic explanation, or an anchor of legal analysis.<sup>22</sup> It is also intended to give a context for J. L. Mackie's conception of a causal field.

Logical causality is that which relies on probability and belief, but within a determined structure of operations with fixed rules. Causality refers to a change in state in a formal sense, as in counterfactual reasoning and conditional propositions. The logical framework relies on set theory, and allows symbolic operations on the implications of a particular conditional combination. There are a number of applications of the logical representation of causality for rational choice decisions in the economic literature (Eells, 1982; Suppes, 1970).

Hume (1740) remains a benchmark for a combination of the conceptual and the psychological in a concept of causality. Hume proposed that causality, as a basis for covering laws, did not exist. Rather, causality 'in the objects' was an illusion, reinforced through "constant conjunction" and "regular succession."<sup>23</sup> He also ventured into the

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<sup>22</sup> Notions of causal power will not be addressed (Harré and Madden, 1975).

<sup>23</sup> It is interesting to note Hume's historically situated skepticism, since the birth of causal determinism in the sciences emerged in counterpoint to teleological determinism during this period. In this debate, Hume took an agnostic view (Mackie, 1974).

psychological in his study of causation, noting that “nothing can count as *necessary* connection unless it will somehow support *a priori* inference in the form of an impression” (Mackie, 1974). This approach belies Hume’s main concern, with induction and inference concerning matters of fact. He remained sceptical that induction could provide knowledge of future events.

Kant’s version of causation was closely tied to Hume’s scepticism. His introduction of the categories and his transcendental idealism did not substantially change the concept of causation as psychologically motivated. For both Hume and Kant, causality was inextricably tied to the investigation of epistemology. According to Kant, we cannot know the objects in themselves (the ‘ding an sich’) but only our perception of these objects, thus forming a somewhat critical realist perspective.

Legal scholars Hart and Honoré (1959) considered causality conceptions to be mainly divided among physical and interpersonal (i.e. psychological) accounts. Their own contribution remained mostly conceptual not in terms of personal perception, but in legal frames of reference. Hart and Honoré made the legal distinction of standing conditions as causes, a concept that is taken for granted in legal debates over liability and responsibility. However, in the traditional causality literature, conditions, as they did not produce time - order change, were not considered as part of causation in philosophical and scientific discourses.<sup>24 25</sup> Towards defending conditions as a type of cause, Hart and

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<sup>24</sup> However, in the power theory of causation, objects have potential, that under the appropriate conditions, cause transformation (this is most like Harré and Madden’s physical account of causation in *Causal Powers*, 1975).

Honoré stressed the importance of the context in defining the normal and abnormal.

Along these lines, the conditions are those (Mackie, 1974: 119)

“...which are present as part of the usual state or mode of operation of the thing under inquiry...some will be familiar, pervasive features of the environment,...present alike in the case of disaster and of normal functioning...by contrast, what is abnormal...makes the difference between the accident and things going on as usual.”

In other words, a cause in relation to one field may be not be identified as a cause in relation to another field. Hart and Honoré remarked (Mackie, 1974: 120),

“But since even the choice of a field is relative to a purpose or a point of view, and since even apart from this what we recognize as a cause, rather than a mere condition, commonly depends on what we knew, or what *we knew first* - or what is closely related to our interests, there is much to be said for Mill’s refusal to distinguish, ‘philosophically speaking’ between causes and conditions.” (emphasis added)

Hart and Honoré also suggested that the identification of relevance and irrelevance of changes is linked to the way interpersonal (i.e. psychological) accounts of causation bind general knowledge and specific cases.

J.L. Mackie (1965) elaborated on this notion of condition, or causal field, from Hart and Honoré and from logician John Anderson (1938). The fundamental aspect of a causal field is to note that (1965: 40) “...what is the cause in relation to one field may not be the cause in relation to another.” Therefore, the choice of the field, and the components or characteristics remaining in the background are influenced by how one frames the issues or study. Such a perspective on causality is particularly relevant for risk and uncertainty - as an analysis of *against which causal fields* such identifications of risk and uncertainty are being construed. Mackie uses the example of the investigation into a house fire to

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<sup>25</sup> John Stuart Mill conceived of causal relations through his Methods of Difference - i.e. causation was essentially framed as a change in state.

illustrate the role of the causal field (Mackie, 1965). He defines a causal relation formally as an INUS condition - an *insufficient* but *necessary* part of a condition, which is itself *unnecessary* but *sufficient* for the result.

“...the history of this house is the field in relation to which the experts were looking for the cause of the fire: their question was ‘Why did this house catch fire on this occasion, and not on others?’ However, there may still be some indeterminacy in this choice of a causal field. Does this house, considered as the causal field, include all its features, or all its relatively permanent features, or only some of these? If we take all its features, or even all of its relatively permanent ones, as constituting the field, then some of the things that we have treated as conditions - for example, the presence of inflammable material near the place where the short circuit occurred - would have to be regarded as parts of the field, and we could not take them also as conditions which in relation to this field, as additions to it or intrusions into it, are necessary or sufficient for something else. “

Distant parallels to Mackie’s approach can be found in the psychological literature, in which causality contains positivist and conceptual dimensions (Waldman, 1992; Johnson and Tversky, 1984). There is not much psychological application of causality as condition and cause. In psychological experiments on causality the emphasis has been on the importance of casual time order (causal asymmetry, Waldmann, 1992), psychological cues to causality (Einhorn and Hogarth, 1986) and the perception that like causes produce like effects (similarity of effects). In one of the more unusual applications, Psychologist Gisela Boehm used the concept of the causal field in her surveys among the German lay public concerning the drivers of global environmental change (Boehm and Pfister, 1998). Even in this work the perception of the causal *relation* (a scientific meaning) is promoted above that of the causal *field* (what is determined as sufficient, but not necessary, background).

In her work, Boehm relied on the results of Johnson & Tversky (1984) suggesting that cognitive representations of environmental risks are based on causal assumptions.

Waldmann & Holyoak (1992) also demonstrated that general world knowledge is structured according to causal knowledge. In other words, how one forms categories from inductive experience is more likely than not to be contingent upon reconstructed causal relations.

Einhorn and Hogarth (1986) followed Mackie's field approach to causality and suggested an analytical framework for risk decision making consisting of four parts:

- causal field or context in which probable cause judgments are made
- use of various probabilistic indicators of causal relations, called 'cues to causality'
- judgmental strategies combining the causal field with cues to causality
- discounting of causal strength by alternative explanations

They shorthand their version as the a, b, c of causality: alternatives, background and cues to causality. Einhorn and Hogarth, however, do not consider a formalization developed in this thesis which provides a more comprehensive epistemological framework.

### **Weight (2) and the Causal Field**

This decision model takes Keynes' weight 2 of argument in a subjective (non logical) sense (i.e. the degree of completeness of information in the mind of the decision maker) and combines it with Mackie's causal field. Roughly speaking, the causal field forms the basis for h, or the body of knowledge upon which to base x, or the evidence in (3). Taking weight 2 in a subjective sense, it is the causal field, or changes in the causal field, which

makes evidence more or less likely to cohere with an argument, thus changing its probability.

Combining the causal field with an epistemological account of relative knowledge at a particular time (as in Keynes' account), one can elucidate the reasons for which decision routines in different domains may conflict and for the different threshold values placed for catastrophic risk (i.e. perceptions of how much the market can bear, those conceptual links to which signals are critical in the marketplace etc.).

Weight of argument, and its counterpoint, degree of belief in a proposition, depends on the causal field taken into account in the formulation of such beliefs. Addition of new information may or may not add to the degree of completeness or weight of argument, as the proportion of relevant knowledge and relevant ignorance. For example, there could be information that might not add to the weight, because such information is not "visible" as a signal in the causal field. As either an understanding of the situation changes, or the causal field particularly changes, the weight of argument (or degree of completeness of information) could change as well.

Economist Jochen Runde (1998) explained how causes are identified in economics, noting (1998: 155)

"...we come up with causal hypotheses by examining the available data and then, on the basis of our existing theories and background beliefs, and guided by something *like the logic of analogy and metaphor*, attempt to isolate factors in the situation in which the explanandum event occurred that may have been responsible for or affected it." (my emphasis)

He considers the definition of causality in economics to include background conditions, or “anything that contributes, or makes a difference, to the realisation of that event in one or more of its aspects.” (1998: 154)

Recognising that there are a multitude of causes from which to select for any particular effect (i.e. diagnostic inference), one would choose those causes that are explanatorily relevant - i.e. those that explain specific aspects of events, in response to mostly why - type questions, (why ‘P rather than Q’) thus limiting the field of relevant variables. Such a level of inquiry is similar to Keynes’ observation that the causal field becomes limited as the probability becomes stronger. The causal field, therefore, is implied in a causal assessment. Runde remarked (1998: 156):

“...the same event may have many contrasts, and since the causes that explain an event relative to one contrast may not explain it relative to another, contrastive questions serve to provide the necessary restrictions on the causes we need to invoke in our explanations.”

Such perspectives on contingent causality highlight the need not for a priori criteria such as the covering law approach, but rather context specific descriptors, such as Clark’s stylized facts. This causal field approach also stresses the contingent nature of economic relations, organizational routines and sensemaking routines (Weick, 1995).

With respect to catastrophe risk and underwriting, a lack of data on catastrophes has led to reinsurers’ employing causal assessments of what *is*, *could be*, or using a counterfactual argument, what *could have been*, under particular conditions. In such a

causal assessment, it is critical to know what is taken as the causal field. These factors could be referred to as the mesh of conditions assumed irrelevant to the activation of change. Without an appreciation of what accounts of catastrophe risk count as standing *conditions*, there could be conflicting assessments of catastrophe potential.

Moreover, unless there is an appreciation for the decision making context, the regularities, and the conventions, it may be difficult to understand how choices become decisions, how action leads to change and how the causal framework mediates the perception of change. Such views are affected by the social practices of an organisation as well as its cultural milieu. Social practices reinforce the categories of decision making, secluding the decision making into a frame of reference, and possibly locking the decision maker into a routine set of outcomes. Through induction and analogy, these categories are created and sustained; through habits of mind, they proceed along a route of tacit structuration, whereby they are flexibly used in novel situations.

## **Conclusion**

The nature of risk and uncertainty is more complex than the categorization provided by Knight based on probability. This chapter argued that a greater historical investigation of probability elucidates the more differentiated meanings of risk and probability in the catastrophe reinsurance context. Knight's dichotomy was compared to Keynes' use of probability based on weight of argument, and his epistemological perspective to the formation of expectation. At the same time, both authors do not broach causality in their decision making frameworks. Indeed, causality is a much more fundamental category to

risk and uncertainty than probability. Causality shapes the very formation of what is considered a risk. Moreover, the causal framework mediates uncertainty as a residual category of knowledge. A risk decision making framework involving causality could find roots in combining Keynes weight 2 of argument with Mackie's causal field.

The role of probability in catastrophe risk decision making is also influenced by the incorporation of scientific expertise. The next chapter provides a scientific primer on catastrophes, climate influences, and the reinsurance industry's assessment of potential climate surprise. Chapter 3 will also provide a brief background and critique of some of the motivating themes in hazard geography, a strand of which outlines decision making patterns among settlers in hazard prone regions and the generation of vulnerability. As with decision making in private sector contexts, the chapter argues that a greater causal component should be included in hazard geography as well.

## **CHAPTER 3**

### **Hazards, Geography and Natural Perils**

## **Introduction**

Reinsurance formalizes catastrophe risk across a number of different natural hazards as low probability, high consequence events. However, the nature of natural peril occurrence is significantly different than the distribution of plane crashes, for example. Geophysical and meteorological research may contribute to the assessment, if not the greater expectation, of catastrophe occurrence. The first part of this chapter will provide a background to several major drivers of extreme events in nature, the scientific uncertainties involved, and the perception of those uncertainties by the insurance sector. Reinsurance underwriters are increasingly relying on formal knowledge via catastrophe models to provide an assessment of potential exposure through their portfolios. At the same time, industry representatives caution against employing the models as truth machines in the depiction of an uncertain reality.

In the second part of the chapter, an overview of several human geography perspectives of disasters is given. While a different tack than the first section, they are in fact linked through the study of catastrophes and the emphasis on individual decision making. The survey is followed by a philosophical critique of the approaches. It will conclude with a proposal for the inclusion of causal elements in hazard geography.

## **Natural Perils and Reinsurance**

The *reinsurance* industry, as mentioned in chapter 1, is particularly concerned with catastrophic risk, since it is precisely these high consequence, low probability contingencies that could undermine it. As such, reinsurers would in theory be concerned

with an increase in exposure to catastrophes, due to a shift in weather patterns and / or an increase in societal vulnerability to large value losses. However, as noted in chapter 1, the one year cycle in reinsurance decision making and the need to provide returns to shareholders substantially weaken both the holistic and the long term in decision making practice.<sup>26</sup> One ready reference of reinsurers to rating has been an industry publication titled CRESTA (Catastrophe Risk Evaluating and Standardized Target Accumulations). CRESTA, jointly edited by Munich Re and Swiss Re, designates hazard zones for different perils, and rates them comparatively, in order to assist in the premium estimate for the underwriter.

While historical evidence, a primary anchor of reinsurance underwriting, may provide some indication of the types of perils habitual to a particular region, a more comprehensive view of the causal interactions of the global climate and local weather patterns might provide a better basis for future expectation. In this regard, research on the El Niño phenomenon and climate change provides important clues to the tendencies of the climate system and their correlations to the intensity and duration of natural perils.

Much of the Earth's weather patterns are governed by energy fluxes, in the form of heat and moisture exchange carried for the most part by wind and ocean currents (Philander, 1998). Any changes in those fluxes, especially extraordinary departures from the observed mean, affect local weather patterns significantly. The El Niño phenomenon is

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<sup>26</sup> The long term approach is more prevalent among Continental reinsurers, with a greater diversity of operations and generally a higher level of financial resources. Continental reinsurers have also relied on

one such example. El Niño refers to a reversal of an entire heat “conveyer belt” located in the tropical Pacific Ocean. Instead of East to West, the circulation moves from West to East. The changing heat gradient causes the waters off the coast of South America, noticeably Peru, to become warmer. It is this signal - increased sea surface temperatures in the mid latitudes near tropical waters of South America - that is a main harbinger of the onset of El Niño. Years in which this reversal occurs are associated with a range of weather “anomalies” globally, particularly temperature and precipitation aberrations. Years in which temperatures in this zone are cooler than normal are called La Niña.

El Niño, however, was not the only climate phenomena to have been observed as a signal of changing weather. British scientist Sir Gilbert Walker, Director General of Observatories in India during the late 19<sup>th</sup> century, observed another phenomenon correlated with global weather anomalies. While investigating the reasons for the disastrous drought at the time of India’s monsoon season, he revealed through meticulous empirical investigation an inter - annual correlative change in atmospheric pressure across the Pacific Ocean. When atmospheric pressure at sea level was high in Darwin, Australia, it was low in Tahiti, and the converse. The phenomenon was termed the Southern Oscillation. Walker noticed a mathematical correlation between such changes and rainfall patterns in distant India, Africa, and South America (Glantz, 1996). Indeed, the Southern Oscillation (with an average cycle of about 4 years but in no way regular) became a herald of approaching El Niño events. While his efforts were partly motivated by regional policy concerns to anticipate future dry monsoon periods in India, Walker’s persistence

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prospective underwriting incorporating formal knowledge for much longer than their British counterparts

led him to pioneer a new field in climate studies, which at the time was neglected in its significance by the scientific community.

For a number of years the El Niño and the Southern Oscillation were regarded as independent phenomena. During the mid 20<sup>th</sup> century Dr. Jacob Bjerknes, a Norwegian scientist, hypothesized a link. Bjerknes formally connected his observations of sea surface temperature changes, trade winds, and Walker's pressure gradient cycle to confirm a global cycle, the El Niño / Southern Oscillation, or ENSO. This new holistic understanding of the Earth's climate motivated global research on the nature of *ocean - atmospheric* interactions. It was notably after the observed El Niño of 1982/1983, accompanied by weather disasters worldwide, that a concerted global scientific effort was undertaken to develop coupled ocean atmospheric models in an aim to understand and predict future El Niño events.

The ENSO phenomenon is usually accompanied by weather extremes across the globe, such as increased / decreased rainfall, unusually intense storms, or rare catastrophic events (Glantz, 1996). In general, it is difficult to predict the onset of ENSO events but relatively straightforward to reach inductively to envisage correlated weather patterns, called teleconnections. The historically informed forecast provides a higher or lower probability of departure from a particular norm for a region. It thus does not formally calculate a probability of particular perils in particular regions, though the mid-latitudes hold tighter correlation to El Niño than other reaches of the globe.

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(Engstrom, 1995).

While study of the El Niño / Southern Oscillation promotes the *global* perspective, it is rather the *local* and *regional* that are of most concern to insurers and reinsurers. Their priority is to glean local probabilities of perils of varying magnitudes within a detailed geographic specificity. Swiss Re investigates the El Niño phenomena in house and pursues the open scientific literature. Based on past records, the company recognizes that the following may be influenced by El Niño (Trueb, 1998)

“increased probability of tropical cyclones in the North-east Pacific region and in parts of the South Pacific; reduced probability of tropical cyclones in the Caribbean, on the East Coast of the USA and in the Northwest Pacific region; increased probability of flooding in parts of the Pacific Coast region of South America, in East Africa, and in parts of Europe and the USA; increased probability of fires as a result of extreme dryness in South-east Asia, parts of Australia and northern parts of South America; increased probability of drought in the Sahel Zone and in southern parts of Africa.”

While anticipating some El Niño events in the late 1980s, the ocean-atmosphere models did not predict the very powerful El Niño during the early 1990s (Glantz, 1996). Such failures naturally damaged scientific credibility. As with any model, the uncertainties are both epistemic in the conceptual understanding of the drivers of El Niño as well as stochastic, in the integration of various disciplines in the modeling effort. At the same time, through subsequent El Niño events, the model simulations can be refined. In historical observation of El Niño during the 20<sup>th</sup> century, the phenomena seems to have a return period of about six years. However, there are certain decades with no impressionable El Niño on record, such as during the early part of the 20<sup>th</sup> century, thus highlighting the surprise potential of the phenomenon.

## **Implications for Reinsurance and Catastrophe Underwriting**

The implications of improved El Niño forecasting (bearing in mind the number of uncertainties in the understanding and integration of the phenomenon in modeling terms) are not entirely clear for reinsurers. Firstly, the temporal dimension of reinsurance decision making must be taken into account. Forecasts of El Niño or alerts that an ENSO cycle has started must be transmitted before the renewal season (for North America, the renewal season is the beginning of January) for the information to make an impact on underwriting. The notification of an El Niño in February, for example, vitiates the effectiveness of such expertise on policies committed in January.

Even with sufficient forewarning, the verdict of El Niño's significance to underwriting outcomes is rather tepid due to lack of geographical resolution of impacts. Dr. Gerhard Berz, chief geoscientist for Munich Re, stated that to his knowledge, "there was no attempt by insurers or reinsurers to alter rates or cover in preparation for the recent El Niño, or after its impact, though certain affected regions may have possibly made some changes." (Beatty, July 1998) Swiss Re, on the other hand, attests to policy changes in Latin America, a region with high correlative teleconnections from El Niño. These include increased probability of floods along the Pacific coast of South America. At the same time, Swiss Re affirmed (Dowding, July 1998)

"For globally operating reinsurers, these local fluctuations more or less cancel each other out if considered on their global book of business. As we are looking for long term relationships, the effects of quasi-periodic events such as El Niño again smooth out. Thus no special consideration is given to such events."

This impression highlights the need to view underwriting in terms of the greater context of reinsurance markets. If weather events are known to correlate globally during an El Niño year, it might prove a liability on even a globally operating portfolio. For example, El Niño usually suppresses hurricane activity in the Caribbean while promoting it in the eastern Pacific (Trueb, 1998). At the same time, it is worth noting that Hurricane Andrew occurred during an El Niño year. While there were fewer hurricanes overall that year as expected, the landfalling hurricanes were devastating due to the particular geography affected. Such an example points to the difficulty in correlating *loss levels* with ENSO criteria alone.

For the present, the London market does not take El Niño as a significant decision factor. As one London market spokesperson remarked “[As far as the London market is concerned] El Niño is not a big event at all” (Dowding, 1998). On the other hand, the El Niño phenomena has varying degrees of magnitude and duration. Some meteorologists forecast, based on past decadal trends during the 20<sup>th</sup> century, a future decade of increased hurricane activity affecting the Atlantic seaboard of the United States (Gray et al., 1998).

The insurance market relies to some extent on risk perception, and as such it is no surprise such coverage of El Niño in a negative sense (while the phenomena also brings some beneficial weather effects) could lead to increased protection. The media play an important role in shaping perceptions and arousing public trepidation in announcing the onset of an El Niño. Such advertisement could lead to changes in the reinsurance markets by enhancing *demand* for insurance and reinsurance protection due to changing

perceptions of weather danger. Such a change was observed in California during 1997 with respect to the potential for flooding (Dowding, April 1998). On the other hand, El Niño may not be solely to blame.

### **Climate Change**

Some scientists propose that global warming may be producing a change in the behavior of El Niño itself (Trenberth, 1999). Atmospheric scientist Kevin Trenberth notes that with global warming (Trenberth, 1999: 11),

“...we should expect higher temperatures in the upper layers of the ocean, and a steeper drop in temperature beneath the surface, which would increase the magnitude of the swings between La Niña and El Niño.”

Greater exchanges of heat and moisture could, on its own, be a signal towards increasing extreme weather, greater than the range of climate variability and local societal resilience might allow.

At the same time, scientists contend that weather anomalies cannot be tied solely to ENSO, but are rather a convergence of interrelated factors, both local and global. Swiss Re publicly stated that (Dowding, July 1998)

“On the basis of current knowledge, major losses in the past can be neither attributed definitely to El Niño events, nor reliable future El Niño loss scenarios be produced. Primary insurers and reinsurers must, however, give their utmost attention to extreme meteorological events.”

Climate change research suggests that if estimates are borne out, an increase in extreme events *generally* is to be expected (Downing et al., 1998). This forecast is the result of Global Circulation Models (or GCMs) which simulate the Earth's climate systems and

also offer future scenarios. Some catastrophic effects “predicted” by the Global Circulation Models include not only weather anomalies, but also sea level rise abetted by the melting of the polar ice caps. The driving force behind the GCM is an assumed overall warming of the Earth’s system due to the “enhanced greenhouse effect.”

The natural “greenhouse effect” of the earth’s atmosphere was described by French physicist Jean Fourier in 1860. The atmosphere acts as a natural barrier to outgoing solar radiation, contributing to a warming on the earth’s surface, much like in a greenhouse. In fact, without a natural greenhouse effect, the Earth would be frosty and uninhabitable. Nobel laureate Svante Arrhenius extended the concept to conceive of an *enhanced* greenhouse effect due to the accumulation in the atmosphere of carbon dioxide, which traps heat in the atmosphere. It was later ascertained that not only carbon dioxide, but also other “greenhouse gases” such as methane can absorb the thermal radiation reflected off the Earth. There has been a much higher rate of greenhouse gas emissions, especially due to industrial activities, than ever before.

During the 1980s, international concern over global warming increased, particularly after a few unusually hot summers. The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 under the auspices of the United Nations Environmental Programme and the World Meteorological Organization (WMO) to provide an assessment of global warming. The international effort includes 500 leading and contributing scientists worldwide, with peer review entailing an extra 1500. They are divided into working groups with responsibilities for a) scientific assessment of climate

change, b) assessment of impacts of climate change, and c) assessment of technological and policy options, given the impacts.

The first IPCC assessment report appeared in 1990, the second in 1996. The second assessment report maintained that “the balance of evidence suggests that there is a noticeable human impact on the climate” and that if nothing is done, the temperature rise could be in the range of 1.5 to 6.3 degrees over the next 100 years, causing a sea level rise between 6 and 38 inches. The warming would also entail larger swings in weather anomalies. Such a projection would exceed human experience in the past millennium, causing “widespread economic, social and environmental dislocation over the next century.” (Watson et al., 1996)

The IPCC assessment of climate change has been centered on the design and outputs of GCMs, which in themselves represent a variety of approaches, assumptions and purposes. The models are approximations of the climate system as it is presently understood, and contain a number of uncertainties. These include the quantifiability of the impacts of sources and sinks of greenhouse gases, the intervention of clouds, the underrepresentation of ocean influences, and the processes governing the polar ice sheets (Houghton, 1997). Sir John Houghton, chairman of the climate assessment of the Intergovernmental Panel on Climate Change observed that to reduce the uncertainties involved, “...much better observations of all aspects of the climate system are required to describe climate variations as they occur and to calibrate and validate climate models.” (Houghton, 1997: 160)

## **Climate Change and the Reinsurance Industry**

The unprecedented insured losses due to catastrophic perils in the late 1980s and early 1990s caused a paradigm shift in the perception of catastrophes by reinsurers. The climate and its effects over the balance sheets of the insurance industry became a focal concern for public – private interaction. The dominant mood of those companies taking climate change into consideration was of the precautionary principle. Richard Keeling, chief executive of the Harvey Bowring syndicate at Lloyd's (one of the largest Lloyd's syndicates and a noted leader in catastrophe reinsurance underwriting) remarked at the time, (Gordes, cited in Freedman, 1997)

“The insurance business is in quite a bit of trouble, so we have to start acting now. [The] climate experts that we hired could not tell us that global warming was to blame for the unusual severity of recent catastrophic storms, droughts and floods. [But] they told us ‘We can't prove there is global warming. But by the time we can, you chaps will be in real trouble.’”

Lloyd's of London Deputy Chairman, Dick Hazell contributed this statement of inductive and causal expectations (Gordes, cited in Freedman, 1997)

“...there is no reason to expect the recent state of disasters was just bad luck or statistical oddity. The long term impact of global warming on the world's weather patterns and the incidence of disasters due to man-made constructions or industry pollution may both ensure that a significant number of large-scale catastrophes occur somewhere around the world each year.”

The General Manager of Swiss Re, H.R. Kaufman, cautioned in November 1990 (Leggett, 1993b),

“There is a significant body of scientific evidence indicating that last year's record of insurance losses from natural catastrophes was not a random occurrence. Instead it may be the result of climatic changes that will enormously expand the liability of the property-

casualty industry. In light of these losses, it would be prudent for the property casualty industry to act *as if that theory (global warming) is correct.*" (my emphasis)

While declaring the urgency of changing underwriting practices is rather simple, implementing a long term program of altered behavior is difficult in a market with a short term memory and a focus on annual underwriting profits. Indeed, American reinsurance companies, mindful of corporate image and quarterly shareholder return, remained for the most part mute on the issue of global warming (Freedman, 1997).<sup>27</sup> The European reinsurance companies, on the other hand, went so far as to sign an open declaration of environmental commitment, shown in Appendix A.

In 1995, the scientific director of Greenpeace International's Climate Campaign, Dr. Jeremy Leggett, mobilized the insurance industry into political action at the IPCC U.N. Framework Convention on Climate Change Conference. Leggett organized a consultative pre-meeting among financial companies and motivated them to act as a lobby against greenhouse gas emissions. For the reinsurance sector in particular, the financial concerns were framed in terms of impending insurmountable liabilities on catastrophe policies from climate change. At the same time, greater saliency of impending weather losses could also boost the demand for catastrophe reinsurance. During the U.N. meeting, Lloyd's, Munich Re and Swiss Re publicly declared the urgency of greenhouse gas emissions reduction (Freedman, 1997).

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<sup>27</sup> Employers Reinsurance Company was the only U.S. insurance company publicly to acknowledge the global warming debate (Freedman, 1997).

At the same time, reinsurers began to develop skepticism for the outputs of GCMs and the credibility of the IPCC. Several reinsurance companies pointed to the discrepancies of forecasting confidence between the first and second assessment reports of the IPCC. For example, French reinsurer SCOR Re noted in August 1996 (SCOR, 1996: 8)

“In 1992 the IPCC issued a report, in which it was said that there would be more storms because of global climate change. However, in the most recent report in 1995 there was little agreement on possible changes in storminess.”

An excerpt from the actual report stated that with regard to tropical cyclones (Watson et al., 1996: 334),

“the state of the art [tropical cyclone simulations in greenhouse conditions] remains poor because (i) tropical cyclones cannot be adequately simulated in present GCMs; (ii) some aspects of ENSO are not well simulated in GCMs; (iii) other large-scale changes in the atmospheric general circulation which could affect tropical cyclones cannot yet be discounted; and (iv) natural variability of tropical storms is very large, so small trends are likely to be lost in the noise...in conclusion, it is not possible to say whether the frequency, area of occurrence, time of occurrence, mean intensity or maximum intensity of tropical cyclones will change.”

Public debate shifted to emphasize the climate’s own natural variability, and the perception of human liability in climate change softened. SCOR Re noted (1996: 9)

“The message as far as climate change goes is that natural climate variability is large compared to human effects. For the next few decades, at least, natural variability as opposed to global climate change is likely to have a much larger impact on insurance business.”

A Swiss Re publication (1998) revealed more skepticism of the applicability of General Circulation Model forecasts to the insurance sector due to their global scale and numerous uncertainties. It stated (Swiss Re, 1998: 4-5)

“The phenomenon of climate change - whether natural, man-made or influenced by man - makes reliable probability statements about future meteorological events impossible. This realisation is one of the most important ever made by climatologists. They therefore talk not of *forecasts* but of *projections*, the estimation of possible meteorological events as a result of possible climatic changes.”

The report also commented that (Swiss Re, 1998: 5)

“...global climate models and underlying damage mechanisms do not offer sufficient material for reliable forecasts for individual areas, let alone predictions of the socio-economic consequences.”

On the other hand, the climate change debate forced reinsurers to re-assess their methods of expectation and their reliance on past losses to forecast the future. The IPCC warned that “This method is clearly flawed if the size and number of weather related incidents are rising.” (Dlugolecki et al., 1996: 551) Indeed, one of the major conclusions of the UK’s Chartered Insurance Institute’s report on Changing Weather Patterns was to “Review underwriting strategies for natural hazards to make effective use of GIS, and to avoid the blind use of ‘return periods.’” (Dlugolecki et al., 1994: 55)

It has been mentioned that ENSO models and GCMs do not offer the scale that reinsurers seek. Certain other formalized models have found their way into reinsurance decision making routines, however. These “catastrophe” models are either produced in-house by reinsurance companies or purchased from specialized firms. Such models have revolutionized the landscape of catastrophe risk decision making from an inductive guesstimate to an advanced level of scientific and financial integration.

### **Catastrophe Models and the Reinsurance Industry**

The presence of catastrophe models as assessment tools for underwriting decision making has rapidly proliferated over the past fifteen years. Part of this growth is due to demand wrought by the insurance sector's "cognition of catastrophe" after the watershed losses of Hurricane Andrew (Meszaros, 1997). Another factor in the models' commercial success is due to the advances in computing power to combine and visually display an integrated hazards assessment. These modeling firms employ a large number of PhD scientists in earth sciences, engineering, and statistics.

The products contain a number of components and are comparable to integrated assessments in global environmental research (Jaeger, 1998; Rotmans 1998). Each component is a mini-assessment of the loss potential and financial consequences of a catastrophe. The models integrate an assessment of the probability of the peril itself in a particular geographic region, the vulnerability of the buildings concerned (materials, construction, environmental conditions) to the peril (of different intensities and durations), the insured values under consideration (proprietary information of the client) and the insurance terms (such as deductibles, reinstatements, exclusions, etc., that affect the liability of the reinsurer). The product thus combines hazard, vulnerability, and insurance variables.

In order to provide an output of probability of losses exceeding a certain level, the catastrophe modelers use two different approaches, one mainly inductive, and the other, causal (Kozłowski and Mathewson, 1997). In the first method, historical data on a particular peril, such as hurricanes, serve as a baseline for trends in a region.

*Deterministic* modeling then uses this data to simulate a number of specific (past) events, which over many events, contains the assumption that outcomes will converge to expected values. The technique in *probabilistic* (or stochastic) modeling, on the other hand, is to run many hypothetical events covering a range of possible outcomes. These two methods allow the modeler to assess the probabilities and severity of loss (i.e. loss likelihood) and a distribution of exceedence probability - the chance that a loss will affect a certain layer of reinsurance protection. While the output is technologically sophisticated and visually stunning, catastrophe models contain a number of assumptions and omissions, both at the level of climate variables and local conditions. The effects of El Niño, for example, have generally not been integrated into models.

As decision support systems, catastrophe models serve a number of functions for the reinsurer. First, they allow the reinsurer to monitor own exposure, or the vulnerability of the properties under contract to particular perils.<sup>28</sup> While most reinsurance exposure assessment was based on past losses, the model allows an updating of current property *values* in the insured regions. Past losses in a region, especially if such losses to catastrophes occurred over a decade ago, simply do not provide the appropriate analogy for the potential of future events. Secondly, catastrophe models bundle the “what if’s” of a reinsurer into measurable outcomes. This simulation exercise over the reinsurer’s exposure permits a range of scenarios that might not have been considered. Third, the catastrophe model is a symbol of sophisticated expertise, but also one that is not embedded in any particular firm. Indeed, the standardization of catastrophe risk

assessment expertise through the models allows them transportability among different firms in the market and in different areas of the same firm. However, the capacity of the user communities to judge the models under appropriate caveats may range markedly from one firm to another, necessitating a formal knowledge learning process. Finally, it is not clear that the prices the models advise would be those offered by the underwriter - market conditions and corporate objectives playing a very influential role (anecdotal evidence).

The main modeling companies include Applied Insurance Research (AIR), Risk Management Solutions (RMS) and EQE CAT. AIR is credited with creating the first catastrophe model, CATMAP, over ten years ago; RMS has its origins among links between engineering professors at Stanford University and a modeling company. EQE CAT is itself a firm of EQE International, a risk assessment company. Most of the models are prepared for specific perils, as indicated with such product names as UK Wind, US Wind, California Earthquake, or UK Flood. However, at least one modeling company, EQE CAT, has produced a model to simulate hazards globally, called WORLD CAT. One of the critiques of catastrophe modeling design is that they do not offer as much attention to the financial dimensions of insurance as they do the hazards and engineering/vulnerability components (Walker, 1995). Such imbalances are understandable, given the highly scientific and engineering oriented expertise being represented in the catastrophe modeling firms.

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<sup>28</sup>As mentioned, one of the surprises of Hurricane Andrew was that it revealed companies' ignorance of

Acquiring relevant data for the catastrophe model can be extremely difficult, notably if past weather conditions have not been well recorded, the reliability and quality of data is questionable, or data are scattered. Moreover, climate data can be, as one cat modeler exclaimed “fiendishly expensive.” (Beatty, 1998) In Europe, such information usually comes at a cost, while in the United States, much of it is available publicly through government agencies, although this is also changing. When data are not directly available, deductive inferences are sometimes made using contingent data. For example, one catastrophe modeling firm digitized six-hourly pressure maps from the UK Met Office to derive windspeeds at high altitudes. On the other hand, cynical modelers advise the adage “rubbish in, rubbish out” as applicable to cat modeling as any other modeling enterprise (Beatty, 1998). The IPCC report itself mentions the problem of inhomogeneities in historical data for catastrophe modeling purposes (Dlugolecki et al., 1996). Such limitations in data should be recognized, as they influence the applicability of the model’s theoretical components.

Mathematician John Casti, himself involved in environmental systems research, provided some caveats to modeling endeavors in a recent *Washington Post* article (Casti, 1997). Casti characterized the two methods of earth system modeling as “bottom up” and “top down.” The first approach, essentially causal, uses particular factors thought to be correlated with changes in the earth system, such as temperature, air pressure and wind speeds at particular locations. The measurements of these factors are then incorporated into a series of physical laws in order to determine an outcome of another climate state.

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their own current exposures.

Casti's tenet is that such physical laws are highly sensitive to initial conditions, making them indeterministic in a chaotic sense and vitiating predictions especially as the time scale increases. The top - down view on the other hand, focuses on observations of previous climate states, and uses analogies to derive forecasts of possible futures on the basis of statistical analysis. Casti questioned the reliability of past data, and the sufficiency of the number of observations used to justify the assumptions employed in statistical analysis. Finally, he remarked "...it's difficult to predict truly novel climatic states from looking at the past, because the statistical models basically assume that the underlying mechanism generating these states has not changed." (Casti, 1997) It can therefore be summarized that models, while focusing on *causes*, do not usually account for changes in *conditions* over time.

Munich Re geophysicist Ernst Rauch also cautions the user community not to consider catastrophe models as predictive tools, but rather as heuristics enlarging the mental set of possible outcomes. Rauch stated (Dowding, 1998),

"It is important to understand that there is a big difference between catastrophe prediction and catastrophe modeling. The term 'prediction' is very often used in a misleading way as it is impossible for anybody to predict catastrophes by means of the exact location, time and intensity of the event. 'Catastrophe modeling' allows the insurance industry, based on scientific and statistical methods, to have a technical, sound understanding of loss occurrence probabilities from a long term perspective."

Indeed, underestimating the uncertainties involved is a grave mistake, counsel two catastrophe modelers from Risk Management Solutions (Boissonade and Collignon, 1999). They take the example of their tropical cyclone model, and the four hurricane

forecasts that were used as a basis.<sup>29</sup> The RMS modelers remark on the spotty success records of the forecasters themselves and that the accuracy of US landfalling hurricanes is “inconsistent.” On the other hand, improvements to the resolution of the models could require “an exponential increase in the amount of data, processing power and money required to build the model.” (Beatty, 1998) Other sources of uncertainty include assumptions from the “raw” data provided in technical estimates of material behavior under stress – to be included in the vulnerability component of the model. For example, the steel frame structures during the Northridge earthquake did not withstand the level of disturbance as had been assumed they would.

At the same time they remain cautious of model outputs, underwriters are already providing recommendations for how models can be more usefully designed for reinsurance decision making. Tim Mardon, underwriting vice president of Bermudan reinsurer Tempest Re suggests that (Dowding, 1998),

“All perils covered by a reinsurance treaty must be included; all assumptions need to be independently verifiable; consistency between model versions needs to be maintained (or very good reasons given why it is not); and costs need to be minimised.”

Even while individual perils and their particular geographic impact may not be predictable, general trends in weather patterns are important for reinsurers. Flooding or cold snaps may have a higher tendency in particular years than others, partially due to the teleconnections of El Niño.<sup>30</sup> The occurrence of wind storms and hurricanes of particular

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<sup>29</sup> The forecasts were of Dr. William Gray at Colorado State University, Dr. James Elsner of Florida State University, Dr. Mark Saunders at University College London, and the NOAA-CPC/National Hurricane Center.

<sup>30</sup> It is less understood how La Niña affects such weather patterns.

intensities and landfalling potentialities are subject to a number of local geographic and temporal conditions and suffer from rather poor predictability. On the other hand, there are particular regions that face a seasonal hurricane threat, such as the Caribbean.

Therefore, reinsurers expect losses in the region over the course of the year. At the opposite extreme, one of the most difficult perils to gauge is an earthquake, due to its relative independence from global climate systems and the scarcity of historical data. Faced with different degrees of loss level predictability, insurers have been focusing efforts at improving loss mitigation (i.e. loss consequences) through building code stipulations and clauses aimed at increasing policy holder responsibilities for a portion of the losses as described in Chapter 1 (Walker, 1995).

While the previous section presented a broad overview of several technical dimensions of catastrophe risk decision making, the next half of the chapter will outline several key influences in the human geography literature on hazards research. It will argue that both positivist and structural approaches neglect the causal framework in their explanations of hazards, vulnerability to loss, and human behavior.

### **Hazard Geography: The Elucidation of Perverse Decisions**

Human geography, more than any other field, explicitly seeks to incorporate a holistic perspective of environmental conditions, societal structures, resource use and human agency. This section will first review some of the foundations, major concepts, and styles of argumentation of hazard geography. The paper will argue that one reason for the eclectic approach in hazard geography is the different philosophical approaches to discuss

reality. These perspectives influence the discussions of risk and uncertainty with respect to catastrophes. This section of the chapter then outlines several critiques within the context of the philosophies of human geography. The discussion will contend that without a more explicit presentation of its causal framework, hazard geography has limited explanatory power.

The field of hazard geography, although influenced by disciplines such as economics, psychology and sociology, at its inception drew upon the case applications of a few prominent scholars, notably Gilbert White (1945, 1972, 1974, 1993), Robert Kates (1964, 1971, 1993), and Ian Burton (1964, 1974, 1993). The work of these geographers is characterized by an empirical determination of hazard perception and decision making to inform public policy, a concern with structure and human agency according to different scales of analysis, and a descriptive account of the generation of hazard vulnerability within the “nexus of nature, society, and technology.” (Burton, Kates, and White, 1993)

In order to contextualize the academic positions within the hazard geography literature, a brief historical synopsis of the development of the seminal works in the field is given below.

After a spate of disastrous floods in 1936 in the Mississippi region, the U.S. national government decided to fund the cost of flood control works whenever benefit cost analysis deemed it of positive value to the community.<sup>31</sup> However, the engineering

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<sup>31</sup> Gilbert White remarked, “It was assumed that what was proposed - as, for example, the reduction of flood losses or the increase in waterway traffic - would in fact be realized if only the proper combination of technical means, discount rates, and time horizons could be found.” (White, 1973: 196)

solution did not lead to reduced flood losses. In fact, they increased. Geographer Gilbert White, influenced by human ecologist Harlan Barrows at the University of Chicago, studied the problem of flood losses, and developed a broader range of alternatives in flood loss reduction.<sup>32</sup> More than a decade later, in 1956, the Federal government chose White to lead a study on the effects of federal investment in flood control works and their impacts on land use patterns. It was thus in response to a public policy imperative that geographical research was commissioned to *explain* the rise in the level of flood losses despite heavy federal investment in flood control engineering works.

The approach by the White team was influenced by Barrows' 1923 study on the social impacts of government engineering construction projects. The investigation emphasized the perception of those living in areas prone to the hazard of extreme events and the choices for adjustment by individuals and governments. The research strategy from the study became the basis for the hazard geography paradigm (White, 1973: 197). As Figure 2 illustrates, the research strategy was one of pragmatism, clinical analysis, and normative application of options.

**Figure 2: Research strategy of the study and guiding questions**

*Research Strategy*

Estimate the extent of human occupancy in areas subject to extreme events in nature  
Determine the range of possible adjustments by social groups to those extreme events  
Examine how people perceive the extreme events and resultant hazards  
Examine the process of choosing damage-reducing adjustments  
Estimate what would be the effects of varying public policy upon that set of human responses

*Guiding Questions*

Why do people locate in areas prone to natural hazards?

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<sup>32</sup> *Human Adjustment to Floods* (1942)

What do people know about these hazards?

How does this compare with what they might know if they had the most up-to-date scientific and technical knowledge?

White defined the extreme event as (White, 1974)

“An interaction of people and nature governed by the coexistent state of adjustment in the human use system and the state of nature in the natural events system. Extreme events which exceed the normal capacity of the human system to reflect, absorb, or buffer them are inherent in hazard.”

White made the distinction between hazards which are relatively rare and those that may be cyclical, by defining the extreme event as that in the geophysical system with high variance from the mean. The “hazard” was the condition of living in danger of catastrophic events. In other words, the hazard was the vulnerability of the human system to the risk of the peril. Human response was encapsulated within the concept of choice of adjustment. The framework for adjustment, as shown in Table 3, begins with the ex ante drivers of natural hazards in the environmental system, to ex post relief and recovery measures (only viewed within the human system).

**Table 3: Common set of response measures to natural hazards**

- affect the cause of the hazard (natural causes)
- modify the hazard (dams to control floods)
- modify the loss potential (develop warning systems)
- spread the losses resulting from the hazard (government aid)
- plan for losses (insurance policies)
- bear losses (stoically accept the bad and good years)

It is interesting to note that the underlying social progress paradigm based on technological solutions and modification of the natural environment never came into

question. Rather, the deciding aspects were human resource needs, economic constraints, and individual perception of adjustment options. The set above is therefore prescriptive, but influenced in conception by the normative framework of rational choice, benefit-cost analysis, and the resource based model of progress.

White et al.'s 1956 study critiqued the government's exclusive focus upon flood-control technology and upstream water management to mitigate flood losses. These so called "technical fixes" excluded other types of adjustments as shown above. The subsequent challenge for the geographic analysis concerned explaining the different behaviors of individuals and groups in coping with flood problems. In White's view, better understanding of human decision processes would inform the implementation of public incentives to "improve the character of their choices over a period of time." (White, 1973)

In the benefit - cost models of federal investment assessments, the individual decision maker was assumed to be utility maximizing. However, with its assumption of complete information of the hazard, its probability and consequences, this model was deemed unrealistic and White's study turned to the subjective expected utility model in order to try to explain actual decisions. In this second framework, individuals were assumed to seek to optimize under conditions of incomplete information and subjective evaluation of consequences. White considered this approach also inadequate to *explain* behavior of individuals in flood plains. An alternative model, economist Herbert Simon's (1986) framework of bounded rationality and satisficing was deemed applicable to study

judgment processes under uncertainty. Simon postulated that individuals do not make choices based on knowledge of all possible alternatives and outcomes. Rather, they rely on the imaginable set of options, often restricted and dependent upon organizational context and information recognition.

White's goal was to enlarge the set of choices for policy with a focus on the individual's decision set. His "adjustment" decisions, or for hazard research the modification of the interaction between the human and environmental systems, took place within the perceptual bounds of the individual decision maker. Different adjustments could thus be justified by the different perceptions of the hazard. This style of argumentation, from a dichotomy of natural and human systems to an individual search for adjustment within bounded rationality, leads to a categorization of individual responses within a context free social sphere. The study thus presents the personal confrontation with the hazard as the main focus, not the social, political, economic or institutional conditions affecting this choice set.

Hazard geography research expanded to include not only flood hazards, but also other types of catastrophic natural perils, such as drought, earthquake, frost, landslide, hurricanes, and volcanoes (White et al. 1974). The basic hypothesis was that rational explanations of persistent resettlement in hazard prone regions were achievable by examining the perception by occupants of the adjustments open to them and their likely consequences. As opportunities are limited to investigate extreme event perception over time due to the scarcity of occurrences in the same location, White sought to compare

among similarities in different cultures and conditions and to categorize human response as ex post or ex ante.

The differences in hazard perception from place to place and time to time were found to depend on the following factors listed in Table 4. It displays that perception of the hazard follows along different external causes and long standing conditions. The table thus takes into account the numerous interacting factors motivating settlement decisions and risk perception. The table also implicitly illustrates the influence of economic decision making perspectives to hazard geography.

**Table 4: Factors contributing to the variation in hazard perception among different people (White, 1974)**

- Combination of magnitude and frequency of the hazard
- Recency and frequency of personal experience, with intermediate frequency generating greatest variation in hazard interpretation and expectation
- Importance of hazard to income or locational interests
- Personality factors such as risk-taking propensity, fate control and views of nature

Perception of adjustment options became a central component in White's study. He modeled the interaction between human and physical systems as a choice process influenced by event characteristics, human experience, resource use, and material wealth. One of the most important among these factors was the familiarity with the hazard and prior experience of other extreme events. Robert Kates referred to this perception filter as the "prison of experience." Since the relevant context was that of choice under uncertainty, the prison of experience concept suited the bounded rationality model. The

economic welfare implications of the hazard were also important, but in combination with personality attitudes towards hazard proneness.

The studies greatly influenced later work on hazards, society and human adjustment. The subsequent research essentially relied on an assessment of macro patterns of settlement and individual accounts of adjustment choice and hazard perception. It focused on the process of decision making, procedural rationality, to determine why apparently sub optimal decisions were made. One underlying prescriptive motivation was that a public better informed would make more rational decisions. The descriptive approach by the White team was therefore greatly influenced in its prescriptive intentions, indeed as an input to policy it could not be otherwise.

As the field matured, more attention was given to the personal psychological coping strategies of individuals with respect to hazards (Park, 1991; Smith, 1996; Palm, 1990). The approach of White's study, holding social and cultural factors constant within the bounded rationality model, did not provide a causal explanation, but rather correlated decision outcomes and features of decision makers. Indeed, the following list of coping strategies may be one important feature of the *causal* explanation of the individual's search for adjustment options in the first place. These personal coping devices and heuristics in the face of low probability, high consequence events (such as technological accidents) are extensively discussed in the risk perception literature (Krimsky and Golding, 1992; Slovic, Fischhoff and Lichtenstein, 1985). Such psychological approaches also aim to systematize perception to a few common variables among decision makers.

The work does highlight, however, that not only economic factors, but also psychological tendencies related to causal perception affect decision outcomes. Several of these coping strategies are listed below in Table 5.

**Table 5: Common coping strategies of residents in hazard prone areas (Park, 1991)**

- deny hazard existence
- doubt hazard will occur again
- attribute responsibility for future events to some higher power or authority (such as God, fate, or the national government) and adopt a fatalist attitude regarding no control over their future
- perceiving a regularity in irregular events
- convincing themselves that a particular hazard is becoming less frequent over time, regardless of evidence

In an updated and expanded version of their 1970s study, *The Environment as Hazard*, Burton, Kates and White (1993) reaffirmed that neither technological “fixes” such as levees, nor behavioral “fixes” such as subsidized insurance will guarantee success in reducing hazard losses, as briefly elaborated in Chapter 1. Rather, Burton, Kates, and White proposed that the generation of “hazard” lies in the nexus of nature, society and technology. Hence, the original dichotomy of human and natural systems was reformed into a causal trinity. Once stated that natural hazards research must take into account both social vulnerability and the external peril, many subsequent hazard studies focused on human economic loss (not environmental loss) and proceeded to develop a research program from which policy recommendations could be derived. This motivation (i.e. one important audience of the work on hazards are policy makers) directed the literature to develop models to categorize hazards using specific (economic) indices, predict hazards, mitigate hazard potential, and prescribe post hazard policy.

In the next section a critique of White's paradigm of hazard geography is given, and it is argued that despite an elaboration of different interactions among nature, society and technology, the lack of elucidation of the causal framework of the study leads to limited explanation of human behavior and a blurring of philosophical positions. Moreover, a study of the causal framework of the individual, as a bridge between inference and belief, might provide more insight into the decisions taken. Along the way, a description of several other works in hazard geography is provided as a counterweight to the White legacy.

### **Critique of the Hazard Geography Paradigm**

The initial approach by Burton, Kates, White and others was to shape hazard research from the perspective of the individual settler within bounded rationality and limited information. While being praised for providing a coherent research strategy, it has been criticized for its focus on the micro scale, its uncritical deployment of the positivist perspective, and the placement of extreme events as the lens through which to analyze society. Moreover, the "nexus of nature, society, and technology" is not provided within a theoretical framework, but rather subsumed in micro studies of the individual decision maker.

The hazard paradigm selected the bounded rationality model to serve as a reference for decision processes and evaluation of error. It served as a framework in which to aggregate results and compare against a common standard of "rationality." At first, it focused on the specification of individual "error" in the interpretation of the environment.

Later work shifted towards predictable error in judging uncertainty, such as that found in the decision making under uncertainty literature in economics and psychology. However, such an approach ignores the social and political context of the decision. Moreover, it homogenizes the populations under study. Simon's decision making model, for example, begins with inductive observation of decision making in organizations to inferences about mental processes, ascribing behavioral results to individual cognitive abilities. His theory uses the metaphor of the computer for the human brain, relating perception, cognition and understanding to "processing." The metaphor is not one to distinguish personal interpretation. Thus Simon's model, as was the aim of White's strategy, assists in comparing among similarities instead of among differences, further standardizing the participants in a study and across studies.

White's research has also been criticized for resolving itself into a "naïve determinism and technocratic optimism" (Waddell, 1977) characterizing the nexus of nature, society and technology. However, it is worth recalling a motivation of White's work to counter a common Federal perception that one policy fix would solve the "problem." Co-author Robert Kates stated "More often...the single fix overlooks some process elsewhere in the chain of causation that either increases the releases, exposures, or consequences of the hazard or introduces a new chain of hazards." (Kates, 1962)

Lacking in the decision making studies is a stated framework of causality in space and time - both at the level of the analysis of interactions among nature, society and technology, as well as the causal framework of the decision maker. For example, in the

former case, there is no distinction made between causality in the *condition* of nature, society and technology and causality in the *change* among the three, as briefly elaborated in Chapter 2.

Finally there is not much discussion of the meaning of risk (other than danger from natural hazards), uncertainty (other than unknown consequences or chance of hazard occurrence), and no discussion of ignorance. This highlights the neglect of an elucidation of the study's causal framework. If uncertainty is not knowing within a known knowledge framework and a known causal framework, would such uncertainty change as surprise or research bring other knowledge frameworks to the fore? Hazard research does not consider the important portal of surprise in human systems to re-evaluate categories of decision making, except in terms of *ex ante* or *ex post* adjustment. Indeed, it may well be that the focus itself, the extreme event, has led to a 'normalization of surprise'.

Kenneth Hewitt (1983) has argued that a macro scale approach would be more enlightening to the model of society - environment interactions with respect to natural hazards. His preferred framework places emphasis on political economic institutions that shape the existence, perception, and response of society to hazards. He claims that social awareness of hazards is rooted in the "ongoing organization and values of society and its institutions" (Hewitt, 1983), and only a structural approach can adequately reveal these essential factors in hazards occurrence and the effects of relief efforts. For Hewitt, the relief efforts themselves do not promote long term adaptation to the hazard, for they are usually directed at re-establishing the societal status quo.

Along similar lines as Hewitt's work, more sociologically oriented research may provide a greater explanatory framework for society - environment interactions and natural catastrophes. One contribution of sociology is to diffuse the boundary between societal and environmental systems and the decision making therein, and to challenge the paradigm of progress. In White's earlier conceptualization, human response was placed as confronting *a priori* events in nature, with little integration of society as *both* human and environmental. Sociological accounts could suggest why choices are formed in the first place, how choices shape decisions and responsibility, and the role of trust among information providers and decision makers. More recent hazards studies have construed natural hazards as constructed through human actions (thereby rendering "natural" as misleading) or at the very least abetted by human modification of the environment. Indeed, Marxist accounts (Blaikie et al., 1994; Hewitt, 1997) emphasize the political economic conditions leading to greater vulnerability to hazards, as well as greater *production* of hazards through human decisions concerning land use and resource management. This trend is a condition of Beck's risk society.

While White focused his work on the micro perception of settlers, he neglects an investigation of hazard decisions over time and within a web of the settler's other decisions. Such related factors include the context of activities and routines of the decision maker. If the extreme event is the reference point for White's micro study, it may not be integrated within the range and diversity of routine decisions and priorities of the decision maker. This lack of context may lead to a false sense of hazard awareness.

Geographer Risa Palm advocates a middle solution, one that combines both individual (micro) and societal (macro) scales of analysis, “a simultaneous focus on agency and structure.” (Palm, 1990:76) Although she recognizes that macro level studies are underrepresented in hazard research, she cautions that an exclusive reliance on either macro or micro level perspectives will present a distorted vision of society - environment interactions and the function of those interactions. She considers feedback and the links among different levels of decision making power to be of central concern. She stresses, along the lines of sociologist Anthony Giddens, that structure and individual behavior are mutually influencing in an evolving process. Several of Palm’s suggestions for future research in hazards include: the contingency analysis of the historical setting, including the nature of the political economy; decision making processes and norms that may be embedded in cultural assumptions; and individual psychological factors affecting the ways in which decisions are made in a certain culture (Palm, 1990).

On a methodological note, the founding works in hazard geography were conceived as a public policy report (whence its teleology) the positivist approach lending itself more readily to policy recommendations and hence also to funding stipulations (Palm, 1990) than more broadly conceived geographical research (Unwin, 1992). At the same time, hazard research in its positivist form contains nearly no discussion of the subjective biases and preconceived categories of the hazards *researcher* with respect to the critical analysis of interviews, problem formulation, and the collection/selection of data formatting (Rubin et al.,1993). With the focus on the subject, how can one know whether

the interpretation is due to data or to the lens of the research strategy? Moreover, if subjective biases exist among individual decision makers in the face of hazard, can such biases be systematically transferred to other contexts for comparison purposes? A more critical approach to interviewing would also highlight the issues of memory in describing past events, false consciousness, and the discrepancy among perception, verbalized attitudes and actual behavior. Finally, the Heisenberg uncertainty principle may well apply: how can one know one is not changing the behavior of the subject by interviewing in a particular way?

From the above discussion outlining different approaches to the study of human decision making and natural perils, hazard geography might find the starting point of contingency and reliance more fruitful than either a resources or vulnerability dominated paradigm. In a study of contingency and reliance, the focus is on structure *and* human agency, on responsibilities, choices, and risk spaces: these are dynamic interactions and settings, spatially and temporally, that are complex in terms of organizational environments, culture, and historical precedent, within which decisions and policy making occurs. Before delving deeper into an alternative framework for hazard research, this section outlines the philosophical bases upon which investigations of human - environment interactions are founded (Palm, 1990; Johnston, 1983). The ontology, epistemology and methodology of hazard geography places it within the broader sphere of human geography - with its own research traditions in decision making and human-environment interactions.

## **The Philosophies of Human Geography: Foundations for a Research Framework**

Human geography, as the study of place, space, and time, is interested in identifying the nexus of influences on human behavior. Four philosophical approaches dominate: empiricism, positivism, humanism, and structuralism (Johnston, 1983). The first two are taken from the scientific perspective, with the latter especially concerned to define what can be known (its ontology) as what can be demonstratively proven to exist (its epistemology). The third approach, that of humanism, is primarily interested in the phenomenal life-worlds and the subjective definitions of meaning in human experience. The fourth approach (favored by Marxists) assumes that certain features, or overall structures, of human environments influence human behavior in a similar manner, regardless of the particular culture or history of the community.

**Table 6: Causality in the different approaches to the social sciences**  
(inspired by Johnston, 1983)

	<b>Empiricism</b>	<b>Positivism</b>	<b>Humanism</b>	<b>Structuralism</b>
Ontology	Facts about reality can be known; Realist	Facts about reality can be known objectively; Realist	Subjective knowledge or experience; Idealist	Behavior result of underlying structures
Epistemology	Observation of elementary parts; Inductive	Search for regularities and general principles; focus on individual elements; Deterministic; Deductive	Emphasizes the thoughts of the individual; Inductive over time but not generalizable over a number of cases	<i>Determinism</i> - structure dominates; <i>Probabilism</i> - different interpretations of the structure; Systems studies
Methodology	Observation of difference and patterns	Set of criteria that permit comparison of all alternatives that exist	Knowledge of truth can only be validly obtained from insights into the life worlds of individuals; self reporting; participant immersion	Theoretical deduction based on common structural features of societies
			<i>Idealism</i> - People build pictures of reality; <i>Phenomenology</i> - Understand behavior without preconceived categories	
Teleology	Verifiable description	Repeatability; Prediction with respect to universal variables; basis for model building	“Verstehen” based on context; not transferrable to other contexts; not repeatable or verifiable; the value of the situation in itself; not useful for model building	Explanation based on categories of labels
Induction 1. number of cases 2. variety of cases 3. time	Based on observation	Not observation but selection of specific cases to support deductive conclusions	Induction only in a single case over time	Induction of a number of systems having similar system-variable interactions
Assumptions	World is realist	World is governable by knowable principles and laws	World is as different as the perspectives of individuals	World possesses unseeable structures that motivate and restrict human action

Causal Frameworks	Causality in the observation of difference and patterns  Critique: does not allow for unobserved mechanisms	Causality in the links between elements  Critique: not allowing for different interpretations of reality; assumption of universality  Causality in either a priori deductive statements or verifiable observations	Causality according to interpretation of the individual  Critique: not providing unacknowledged causes of social or spatial organization	Causally deterministic deductively from the structure  Critique: can provide for all facts so cannot be objectively falsified; cannot predict a priori specific outcomes; can become retrogressive-what influences what and how?
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Table 6 relates the four main philosophical approaches to the study of human - environment interactions with firstly, their basic ontological, epistemological, and methodological positions. It then describes the teleology of the different philosophies, or in other words, the goal of the inquiry (related to its ontology and epistemology especially). The inductive positions of the different approaches are not the same with respect to their emphasis on number of cases, variety of cases, or change in a particular case over time. For example, empiricism assumes a realist ontology with an inductive epistemology stressing all three components, while humanism, in its idealist ontology and interpretative epistemology, the change of one particular case over time within the same interpretive viewpoint may be the extent of its use of induction. Finally, the other two philosophical approaches, positivism and structuralism, both use deductive epistemologies but inductive methodologies. The assumptions simply reiterate the nature of the ontologies of the different approaches.

The causal framework is the essential interest of this study, because it is through the causal framework that explanation is constructed. Empirical approaches seek causality in instances of visible change in *observed phenomena*, but what of changed attitudes? Humanist perspectives take the causal interpretation of the subject as the most relevant, and do not impose a causal framework from the outset. From Table 6 one can see that White's research paradigm has been empirical and positivist, in the search for regularities with the aim to be able to predict, based on these regularities, behavior with respect to certain policy instruments. The causal framework is deterministic, and thus does not allow for different interpretations of reality. On the other hand, the structuralist position, taken by Hewitt, contains a macro determinism based on certain common structural features. In these two examples, positivist and structuralist conditions, causal determinism plays a large role in drawing broader, deductive conclusions from certain facts about society or individual behavior.

If one were to take Table 6 and combine it with discussion of catastrophic risk, one could devise a model for the projection of catastrophic risk among different groups in society. For example, insurance companies promote a positivist view of risk via induction in terms of number of cases, analogies with other cases, and behavior of cases over time. In order to price based on frequency probability, a positivist, regularity theory of events is required.

On the other hand, there has been difficulty in ascribing similar risk perception (or interpretive reality) to people within different communities, roles, and cultures. To attach

a risk perception as common to a population suggests the creation of a standard of rationality, which could be said to be the positivist test of a hermeneutic approach. If risk perception depends on the framing of risk and uncertainty, then it is the interpretation that is at issue, not error.

An analysis of human agency in catastrophes is a salient theme in the creation of hazard studies, the concepts of control and surprise (also measured on positivist scales), and the vision of nature as object and force, as stationary and dynamic. One influence is the literature on possibilism in human - environment relations. The environment is neither the passive nor the dominating force but rather a interactive force, altered over time through long term adaptation and short term adjustment.

This table may also provide a useful framework to discuss risk, uncertainty, and ignorance because so much of what is considered as risk phenomena are causally related to their observation and perception. If risk and uncertainty together form the basis of our understanding of a particular set of phenomena, then it is essential to examine also the causal framework within which risk and uncertainty have been demarcated. In other words, what is the causal framework of the risk epistemology? In the positivist tradition, risk and uncertainty are measurable and visible. In the humanist traditions, risk and uncertainty are interpretations of reality and are not transferable among people. Ignorance in the positivist case is not knowing what one does not know, but within a clear framework of how to know (epistemology). However, in the humanist case, ignorance is

related to a relativist interpretation of reality, and is therefore not analyzable as a general case.

While within human geography the debate has centered on the link between structure and agency, it may be a more fruitful task to attempt to bridge the two. One approach linking structure, process and the nature of experience might be found in stylized facts of decision making routines in organizational environments (Clark, 1998b). In this case, the concepts of contingency and reliance may become useful in describing the framing of risk and uncertainty. Contingency refers to a state at any particular time, and reliance, those measures employed or “recruited” to respond to a hazard. The themes of risk and responsibility are overlaid in the manner of the production of the vulnerability to hazard and the public / private roles of protection. This theme will not be pursued here, but simply stated, the emphasis on vulnerability in current hazards studies neglects the agency of the individual within the realist framework of contingency and reliance.

## **Conclusion**

While for the most part reinsurance relied on a purely inductive epistemology to guide future underwriting expectation, this chapter outlines the changes taking place incorporating formal knowledge from meteorology and earth sciences. At the same time, assessments of climate change and increased storminess are greeted with skepticism, mostly due to the differing scientific conclusions over time from international organizations such as the IPCC. Catastrophe models, however, have gained a foothold in the reinsurance practitioners’ routines of decision making.

The second part of the chapter presented an overview of hazard geography and its different perspectives. Hazard geography was founded on accounts of decision making in the face of catastrophe risk, but did not incorporate a strong causal element. Indeed, the literature borrowed from the economic decision making literature and presented the settler in hazard prone regions as operating under bounded rationality. The diversity of approaches within hazard geography has increased since the seminal works of Burton, Kates and White. A critique of the “paradigm” of hazards research is given within this context. The foundations of the different studies are reflected in the philosophical perspectives of human geography, which may also elucidate the framing of risk and uncertainty, as briefly discussed in Chapter 2.

Most views of insurance in hazards geography has been as private / public mitigation options, as discussed in Chapter 1. There has been little work on opening the black box from the underwriter’s perspective of *catastrophe contracts*, and virtually no commentary on the role of reinsurance. The next chapter points to some of the main features of the milieu of the London reinsurance market and the conditions under which risk decisions are framed. Afterwards, Chapter 5 will outline the theoretical literature on decision making under risk and uncertainty with special regard for treatments of causality.

## **CHAPTER 4**

### **The London Reinsurance Market**

## Introduction

The previous discussion of risk, uncertainty, hazards and reinsurance will in this chapter find a context in the London reinsurance market. Much of reinsurance is based on long standing tradition and particular institutional - commercial routines of decision making. It is unique among economic sectors for its emphasis on future events to determine total costs. In other words, the reinsurer derives premium income on contracts for which there is no guarantee of a loss - free year. Reinsurance as a practice is thus tied to three main factors which depend on capacity, time, and space: capital in the market, the renewal seasons, and distribution of risk. This chapter will outline a brief history of the London market and Lloyd's, the importance of local expertise, and the presence of the *catastrophe* reinsurance market. It will then describe some recent trends in the London market that affect underwriting traditions and corporate priorities. The chapter will conclude by describing some primary features and artifacts of underwriting decision making.

It was as much a world of expectation, assessment and decision making in the 17<sup>th</sup> century, when the London market was transacting insurance business out of a coffee house run by a certain Edward Lloyd. The capital providers came to the site to meet those in need of coverage, primarily merchants delivering cargo on the high seas. Bottomry, or a practice of collective risk sharing in marine affairs, had already been established in ancient Assyria (Bernstein, 1996) and therefore the arrangements being struck were in no way novel to human societies. The creation of an institution for risk sharing was. Lloyd's the market organization developed from Lloyd's the coffee house. The ever present

*Lloyd's List*, a marine trade newspaper, is in fact an artifact of the broadsheet posted outside the coffee house to inform the risk traders of the fate of ships and the development of marine affairs. Lloyd's grew into a risk market from these beginnings as a meeting area to exchange information and risk liabilities. Thus, the present Lloyd's is not a single company, but a risk trading organization, with a number of different syndicates, or mini-firms, operating in tandem to spread risk liabilities and in competition to outperform the market.

Lloyd's operates within the context of the London market, or the density of companies, both British and international, that service the reinsurance market. The London market is famed for this concentration of expertise and capital capacity, although its image as a pre-eminent center of underwriting excellence has faded somewhat. Part of London's lustre was lost in the scandals that affected Lloyd's and others in the last century and more recently in the 1990s. The earlier misdemeanors involved betting on the longevity of famous personas (leading to a loss of life assurance services). The later infractions engaged a much larger audience, as Lloyd's suffered the exposure of mismanagement and unscrupulous underwriting by a few underwriters.

Lloyd's had been granted a special exemption in the Financial Services Act from government regulation, and it was the special status that Lloyd's enjoyed, in addition to its association with the upper classes, that attracted capital. It was as much an honor to be affiliated with Lloyd's as a Name, or a capital provider, as it was a financial opportunity. The Names, however, were for the most part naïve investors. Their knowledge of internal

market routines was very limited and much of the reason for signing into “unlimited liability” was the expectation of receiving a prestigious annual cheque (Raphael, 1995).

The cultural repercussions of the contemporary scandal was to reduce public confidence in Lloyd’s as an institution representing certain civic ideals of commercial behavior.

Lloyd’s could fare no worse than to be tarnished in the public eye, to lose civic trust in its operations as a public institution. Its self regulation *modus operandi* was revoked. The burnished image of the Names and the Lloyd’s traditional routines have been irrevocably replaced by the transforming wand of corporate capital.

### **The London Market and Lloyd’s**

Geographically, the London reinsurance market is mostly concentrated in the City, London’s one square mile financial district. In this proximity are 78 active Lloyd’s syndicates and 87 active companies serving non marine risks (such as property catastrophe reinsurance, the focus of this study). The business is mainly concentrated in the Lloyd’s building and the London Underwriting Centre, with various other company offices within walking distance. Direct insurances, reinsurance, and retrocession are all serviced within this area. The proximity allows for frequent and repeated face to face negotiations and the highly embedded transfer of information and expertise through social routines.

Competition is rife with reinsurance markets in Bermuda, New York, Zurich and Munich. Each center of commerce has its own reputation or character for its approach to taking

risk and taste for innovative techniques. London is seen as a liberal market, and indeed accepts some of the most unusual and difficult risks. Of the more noteworthy have been Richard Branson's worldwide hot air balloon attempt, the legs of the Spice Girls, and the Millennium Dome. This flexibility in risk acceptance has also meant that the London market is prone to encourage innovation in risk contracting and in packaging the boundaries of liability of the legal contract to produce a singular risk instrument.

The London market is also characterized by a relative lack of legislative encumbrance compared with other centers, increasing the flexibility of its underwriters. According to insurance scholars Carter and Falush this market environment is structured by absence – i.e. by (1997:3)

“...an absence of tariffs or cartels, the relative ease of entry and exit from the market (for brokers as well as insurers), the rapid dissemination of market knowledge, and the absence of intrusive legislation.”

While Lloyd's formed through the development of small syndicates dealing in the risk market, its two main competitors, Munich Re and Swiss Re, both emerged as the consolidation of small banks and insurance companies during the late 19<sup>th</sup> century. Therefore, the historical contingencies shaping the nature of these capital bases are substantially different in form and obligation. A more recent catastrophe reinsurance market competitor (as of 1992), Bermuda, is pursued by North American corporate capital and reporting requirements. Bermuda also has a history of serving as the location of choice for captive insurance companies of American corporations. With respect to market dominance in providing catastrophe reinsurance coverage, an estimate performed

in 1995 placed the London market at about 20% with Bermuda also at a quarter share and the continental companies taking about half of catastrophe premia (Engestrom, 1995).

The decision by an insurer or reinsurer whether or not to accept a risk is very much dependent on the availability and price of reinsurance - hence the growth and importance of London's retrocession market (the reinsurance of reinsurance) . Indeed, reinsurance dominates insurance transactions overall in the London market, at about 60% of gross premiums. Total reinsurance premiums amounted to 4.4 billion pounds in 1995, of which 3.4 billion related to *non-proportional treaty* business, such as catastrophe excess of loss.

With the attendant face to face negotiations and frequent socializing among London market participants, it is no surprise that most risks in the London market are placed on a subscription basis with reinsurers pledging protection for a percentage of a layer of the risk protection, usually displayed on a broker's "slip." This slip, to be outlined later in this chapter, displays the essential details of a risk in a standardized format. In a sense, the artifact of the "slip" serves to maintain the homogeneity of decision making while allowing for the diversity of risk characteristics.

Over 85% of catastrophe excess of loss (reinsurance) underwriting is broker led in the London market, and indeed Lloyd's operates exclusively through Lloyd's accredited brokers for catastrophe placement (Swiss Re, 1995). The broker usually approaches one or more "lead underwriters" in a particular line of reinsurance, such as catastrophe excess of loss (or cat XL). They negotiate first with the lead underwriter of particular lines the

terms and conditions of the contract, then perform the “leg work” negotiating with other market underwriters to fill the remainder of the slip. While Lloyd’s leaders set the terms and conditions of over 2/3 of reinsurance contract, the Company Market dominates gross premium income in the treaty reinsurance market, with a 67.1% share in 1995. Therefore, it could be said that Lloyd’s leads the way for the London market to follow in many risk subscriptions. Brokers usually recognize the underwriters in their specialized lines, again assisted by the geographical concentration of the London market.

According to Carter and Falush (1997: 3)

“...brokers can know personally the strengths, specialisms, and reputations of underwriters and insurers with whom they deal, and readily tap the combined underwriting capacity of all sectors of the market. Similarly buyers can meet insurers, and market information is spread rapidly among all participants.”

All risks are broken into time and space components, for which the underwriter must have special sensitivity in recognizing. An example is the temporal and spatial degree of liability. Underwriting holds much occasion for personal ingenuity, and particularly good underwriters are singled out in the market. Indeed, the judgments of the lead underwriters on premium rates and conditions are quickly disseminated in the market, mainly through broker - underwriter face to face discussions. If the terms of the leading underwriter are not acceptable to market followers on a particular risk, the broker could renegotiate with another lead underwriter, a social practice that the lead underwriter must take into account. It is in this manner that the subscription market has operated for centuries, as an institution of self-enforcing social practices, as well as a medium for market knowledge.

There has been some effort to introduce cost and time savings of the face to face negotiations via an electronic risk placement system. One such system is the London Insurance Market Network (LIMNET), intended to link insurers, brokers, and market processing centers. It operates via an electronic placing slip (called electronic placing support, or EPS) which would allow a broker to deal with both Lloyd's and the Company Market. In the 1993 Lloyd's business plan, it was envisaged that all new Lloyd's business would be electronically placed by 1996, and that the Company Market would follow. As it happened, the system did not take root at Lloyd's, providing only some placement support. It has been argued that the catering of the London market to complex risks promotes the importance of a multi-layered negotiation. While time-consuming, negotiations and face to face discussion hold great sway among practitioners. A Swiss Re study noted that (SIGMA, 1995: 4)

“...despite highly developed information and communications technologies, the nature of the risks dealt with continues to require personal contact between the parties to the transaction.”

Supporting the London market is a dense network of related services. For example, premiums and claims are processed centrally in two units, the Lloyd's Policy Signing Office for Lloyd's and the London Processing Centre for the Company Market. The City is also home to expertise from insurance organizations and consultancies such as the Association of British Insurers, the International Underwriting Association, the Chartered Insurance Institute and Eastgate Ltd. Thus the London market is not simply an area of transaction, it is a space of expertise in the insurance world. The styles of operation are as diverse as the different Lloyd's syndicates and companies involved.

## **The Company Market**

The main players in the Company Market (as opposed to Lloyd's) are UK composite insurers, reinsurers and branches of foreign subsidiaries. The International Underwriting Association (formed at the end of 1998 by the merger of LIRMA, the London Insurance and Reinsurance Market Association, and the ILU, the Institute of London Underwriters) comprises most of them. In 1993, over 60% was foreign owned, with 20% from the USA, 13% from France, 9% from Germany and less than 30% from the UK. While geographically more dispersed than the Lloyd's syndicates, the Company Market has recently begun to centralize itself in the new London Underwriting Centre - a site intended to become a mini- Lloyd's and devoted to mostly non-marine reinsurances. The LUC contains approximately 30% of the core Company Market companies (Carter and Falush, 1997: 7).

Very recent proposals for greater efficiency in the City have placed the Company Market operations in closer coordination with Lloyd's. One such venture is the "one market, two systems" approach. As Lloyd's and the Company Market are serviced by separate policy and claims processing centers (the Lloyd's Policy Signing Office and the London Processing Centre, respectively), there are movements afoot to consolidate these operations, reduce costs, and increase the use of electronic commerce. An IUA - Lloyd's forum has been created to address such issues (Jackson, 2000).

Both organizations may also combine efforts in areas such as training or education. Tim Carroll, IUA chairman and Chief Executive of German reinsurer ERC Frankona (owned by American reinsurer Employer's Re), proclaimed at a lunchtime lecture at the Insurance Institute of London that (Jackson, 2000: 26)

“The London market has contained too many archaic practices, and it would have to be reformed if it were to retain its position as the world's leading insurance marketplace.”

Carroll, as head of a German reinsurance company, has exposure to cultural organization practices different from those who have only experienced the London market in British companies. Indeed, such internationalization of practices is beginning to seep into the very fabric of the London market for the first time through cross ownership of British companies by Continental and American firms.

These changes to the London market are seen as increasingly urgent in light of long standing resistance to market adaptation as well as the shock from a series of surprisingly large loss events. Between 1987 and 1992 the London market experienced severe losses due to a series of catastrophes: natural (Hurricane Andrew), technological (Piper Alpha) and legal (asbestos). These losses occurred during a period of low insurance demand, low premium rates, and large exposures in U.S. liability reinsurance and catastrophe risk.

Moreover, under-rating of catastrophe excess of loss contracts, as well as a lack of monitoring of aggregate exposures led to a market meltdown in the early 1990s (Raphael, 1995). Some market participants reported a combined ratio (losses and expenses over premia) exceeding 150% in non-proportional treaty reinsurance in the years 1990, 1991 and 1992 (SIGMA, 1995: 23). This figure means that for some firms, losses exceeded

premiums by 50%. Such exposures led several companies, mostly smaller ones, to retreat from the market (SIGMA, 1995: 29). Market capacity, the available capital against which underwriting takes place, fell drastically, leading to rising prices among the survivors but also promoted the newly formed competing catastrophe reinsurance hub in Bermuda. The result of the severe capital contraction further led to consolidation among companies and brokerages in the London market. Those fewer firms that remained consequently hold substantially greater financial clout.

With respect to the string of catastrophe losses, former Company Market reinsurance executive Leslie Lucas stated of the prior assessment of catastrophe risk (1996: 93)

“Some of the recent catastrophe losses have been much bigger in insured damage than either the insurance or reinsurance market expected. The European storms of 1990, the Japanese Typhoon Mireille of 1991, Hurricane Andrew of 1992, and the Los Angeles earthquake of 1994 were all insured loss amounts substantially higher than the market’s perception of the insured exposure.”

### **Lloyd’s**

Lloyd’s is exceptional in many ways in the London market. Part of the unique nature of the institution was its self-regulation, leadership, authority in risk judgment, and the unlimited liability of its “shareholders” or Names. Moreover, Lloyd’s underwriters have traditionally held greater freedom than their Company Market counterparts in underwriting decision making (Carter and Falush, 1997: 21). The reputation for informed judgment at Lloyd’s was a main factor in its rise to pre-eminence. The institution employed Lloyd’s agents worldwide to report on *local* conditions in shipping, cargo, and the conditions of insured articles.

Lloyd's was also well regarded for its innovative risk sharing ingenuity. In the late 1890s, Lloyd's underwriter Cuthbert Heath allegedly developed the excess of loss contract, the basis for most catastrophe coverage today. Heath was also credited with developing the stop loss reinsurance contract, mostly servicing coverage of the hail peril. Such clever application of business creativity and market conditions was paralleled less than a century later when lead underwriter Robert Kiln developed the wording for the catastrophe excess of loss contract using *time* to determine the legal boundaries of liability arising from a catastrophe. This wording soon became a market standard and will be discussed in more detail further in the chapter.

Until recently, Lloyd's base of capital was supplied by private individuals, called Names (they could either be working Names, who held positions in the Lloyd's market, or external Names, who were not members of the market). Membership among Lloyd's Names was restricted to those who could evidence personal wealth of a certain magnitude. This criteria was essential since membership in Lloyd's, unlike in a stock company, stipulated unlimited liability.<sup>33</sup> The Names suffered enormous losses during the late 1980s and early 1990s. While the external loss events received the greatest press attention, there was another market disaster that underpinned the unraveling of Lloyd's risk spreading function: the excess of loss spiral. Indeed, it was this spiral that caused the losses to mount inexorably towards the catastrophic for most of the London market.

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<sup>33</sup> Lloyd's did not admit non British Names until the mid-1960s.

The spiral concerned retrocession of excess of loss contracts, transacted through brokers, which in the end *concentrated* risk instead of spreading it. The upper levels of reinsurance protection had been transferred *back* to those who had underwritten at the lower levels of the *same* risk, thus nullifying the beneficial effects of risk sharing. Moreover, at the upper levels of catastrophe risk (i.e. reinsuring against very high losses with little likelihood of occurrence), the transparency of the nature of the original risk was greatly reduced. Hence, the spiral has been described as “opaque retrocessional underwriting where accurate estimation of exposures was difficult.” (Miller, 1997) Moreover, herd behavior of the market’s underwriters sanctioned the spiral, since it became a way to generate extra premium at unlikely loss levels. While the spiral was mediated by brokers, who received commission on each transaction (thus increasing the incentive to create greater numbers of transactions), the brokers themselves did not have responsibility for the risk liabilities (Raphael, 1995). It was a paradigmatic example of moral hazard at work.

In response to the enormous losses and subsequent bankruptcy of a number of Names, Lloyd’s the institution responded with several task forces and assessments, finally culminating in the Reconstruction and Renewal Plan. The main problem affecting Lloyd’s was considered to be a lack of assessment in underwriting, the dent in capacity caused by Names leaving, the rising costs to transact business, and the previous system of self regulation (Carter, 1997). The Reconstruction and Renewal Plan proposed that liabilities for pre-1993 underwriting years be concentrated in a reinsurance company called Equitas, and that beginning in 1994, corporate capital with limited liability would be allowed in the market. This plan was accepted by Lloyd’s members in September 1996.

A new arrangement with the Financial Services Authority to grant *limited* autonomy to Lloyd's also went into effect. While the Corporation of Lloyd's oversees the affairs of Lloyd's as stated in the various Lloyd's Acts from 1871 until 1982, the Council of Lloyd's is responsible for the day to day regulation of the marketplace and coordinates with the FSA. Another difference at Lloyd's as a result of the Reconstruction and Renewal Plan has been the "accumulation of immense power within the management hierarchy of the [Lloyd's] market" (*Reactions*, March 1999), strengthened in part by former Chief Executive Ron Sandler and former Chairman Sir David Rowland. The governance of the market within a market has intensified, leaving the competing syndicates with fewer discretionary powers than before.

Although during the early stages of the entry of corporate capital, Lloyd's did not allow foreign ownership to exceed 20% capacity of a particular syndicate, Lloyd's now allows 100% dedicated *corporate* syndicates and foreign ownership of syndicates (Carter and Falush, 1997). The dominance of corporate capital (by 1997, it amounted to over 60% of the total Lloyd's market capacity) is changing the way underwriters approach capital and its obligations. The investors are certainly not naïve, but financially sophisticated, if not always familiar with reinsurance or traditions in the London market. Indeed, one of the significant influences is the *culturally conditioned* nature of the capital provision - most of the new capital is American, which increasingly impresses upon syndicates to assume *risk-based capital allocation* and quarterly reporting requirements, in stark contrast to Lloyd's own annual venture of syndicates and the three year accounting cycle.

Although Lloyd's officials publicly supported the entry of corporate capital, some market participants did not share a sanguine view of its effects on the organization. Graham McKean, chairman of the BMS Group at Lloyd's remarked that "Corporate capital will embarrass us. It is pushing for growth, which is wrong in an environment where it is difficult to earn money." (*Reactions*, March 1999) Of greatest concern is that such growth is demanded in much shorter time periods, with far less acceptance of loss years.

Partly as a result of risk based capital coming to dominate underwriting decision making, as well as the memory of large losses due to natural catastrophes, the Lloyd's hierarchy now requires that syndicates submit catastrophe loss estimates based on stipulated Lloyd's Disaster Scenarios. These measurements of catastrophe loss potential are also required by rating agencies. Standard & Poor's for example has recently included a special assessment criteria based on companies' exposure to catastrophe risk, a critical spur to the Lloyd's management to countenance the incorporation of these scenarios at the level of the organization (Miller, 1997). Such scenarios include a Los Angeles earthquake with \$50 billion in insured losses, or a USA windstorm with similar loss levels.

### **Trends in the London Market and Lloyd's**

The London market has been experiencing a range of far reaching changes in the last few years. The most significant trends concern the consolidation of the Company Market and the Lloyd's market, the tarnishing of Lloyd's once resplendent reputation, the entry of

corporate capital, the intensified use of information technology, and the possibility to securitize high loss layers in lieu of reinsurance.

The consolidation in the London market is not limited to reinsurers, and certainly not to the insurance sector.<sup>34</sup> The drive to obtain greater capital muscle in the face of competitors was a substantial corporate theme during the late 1990s. Some headline mergers included direct composite insurers General Accident and Commercial Union forming Commercial General Union, or CGU in 1998. Swiss Re reacquired Mercantile and General Re (the oldest UK reinsurer) in 1997 while selling its own life operations. The world's largest reinsurer Munich Re purchased American Re, the third largest American reinsurance company, in 1996, while French company Axa Re acquired the UK's Sun Life and Provincial Holdings and the Guardian Royal Exchange. Bermudan reinsurers have also merged and bought into Lloyd's syndicates, and American Berkshire Hathaway, through its ownership of General Re, took over Lloyd's syndicate DP Mann in 1999. Due to mergers, acquisitions, and divestitures of specific operations to other insurers, the London market has seen the total number of reinsurers and syndicates decline.

This trend leads to three immediate consequences. The choice for reinsurance capacity in the market has become increasingly limited, but the security (or capital backing) of those

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<sup>34</sup> Certainly the trend in international and domestic mergers are not unique to the insurance world. Mergers in almost all the financial services, accountancies, and industrial giants have occurred throughout the 1990s. Perhaps one of the most spectacular has been the merger of Citicorp with the Travelers Group to form the enormous banking and insurance empire. Another has been the merger of Deutsche Bank with Bankers Trust.

remaining has increased, highlighting the importance of “ratings” by Standard and Poor’s and others to one’s reinsurance marketing. There has been a noticeable “flight to quality” by reinsurance clients after the catastrophes of the early 1990s. Indeed, the market has seen security ranked higher than price by a number of brokers. Secondly, international mergers could lead to national loyalties becoming less of a factor in the marketplace. Finally, the fewer corporate players, especially in the Lloyd’s market, mean that the subscription ideals of the market would likely be weakened (and consequently less discussion of risks among underwriters from different companies would take place.)

Below in Table 7 are the top 20 reinsurance companies in 1997 according to their net written premium (figures in \$US million). Among the headings, technical reserves refer to the security or capital backing of the company’s policies, while retroceded percentage refers to how much of 1997 reinsurance business was subsequently reinsured with another company. NWP refers to net written premium (or income after retrocession costs), and the combined ratio is the fraction of losses to premium income. As a market organization, Lloyd’s holds a unique status that prevents it from listing detailed market data on individual syndicates (n/a refers to not available in the table).

**Table 7: Top twenty reinsurance companies in 1997** (*Reactions*, March 1999: 33)

Rank	Company	Country	NWP 1997	Retro- ceded	Technical Reserves	Combined Ratio	Rating
1	Munich Re	Germany	9606.6	11.5%	27775.9	120.0%	AAA
2	Swiss Re	Switzerland	4282.9	3.7 %	9290.4	107.6%	AAA
3	Lloyd's	UK	4137.3	n/a	n/a	n/a	A+
4	Allianz	Germany	3323.3	38.2%	11730.8	100.8%	AAA
5	Generali	Italy	2550.8	7.7%	5837.4	112.8%	AA
6	General Re	USA	2541.1	17.7%	8056.3	99.4%	AAA
7	American Re	USA	2491.7	16.6%	6670.8	104.0%	AAA
8	Cologne Re	Germany	2274.6	16.1%	4758.8	100.9%	AAA
9	Hannover Re	Germany	2052.7	28.0%	4744.9	103.7%	AA+
10	Gerling Global Re	Germany	1970.9	20.1%	5325.8	103.8%	AA-

While Munich Re and Swiss Re take the top two spots, Lloyd's as an organization signals its international presence at number 3. Lloyd's A+ rating (hopeful, yet not stellar) points to its recent troubles and the strength of its recovery plan. Of the ten in this survey, 6 are German or German owned (i.e. American Re is owned by Munich Re) with inter-ownership structures among the German companies (Allianz, for example, is a significant owner of stock in Munich Re and vice versa). It might strike one as odd that Munich Re has a combined ratio of 120% and yet a perfect rating. This apparent paradox is due to Munich Re's overall financial performance from investments and premium income. Lloyd's, on the other hand, is not allowed to invest in anything other than government bonds, signaling the important role of *underwriting* returns in the organization's overall financial health.

The consolidation trends in the London market have also affected the role of brokerages. Previously in multitude during the late 1970s and early 1980s their numbers have greatly

reduced, and they have grown larger. Their primary role, of negotiators, intermediaries, and information providers, performing much of the “leg work” within the London market, has become one of providing a range of risk management consulting. Brokers now advise clients on a multitude of financial and portfolio stability issues, including the emerging potential of securitization and integrated risk management related to catastrophe modeling. One brokerage agency, itself a result of a merger, now funds a research unit at the University College London to inform the brokerage on modeling relating to natural catastrophes.

The newly merged brokerages have sufficient muscle to raise market wide concerns of their negotiating power vis à vis underwriters. Such is the extent of the industry’s consolidation that by some estimates, Marsh & McClelland and its main competitor, Aon, now control about 80% of the London market business. As the reinsurance underwriter’s main business provider, such powerful brokers could lead to pressure on risk acceptance and risk choices.

Pressure on underwriters to work ever more swiftly is increasing as information technology, substituting in some instances the social routines of information gathering, gains a greater market foothold. In a recent study by PricewaterhouseCoopers, the London insurance market’s administration costs amounting to 1 billion pounds could be reduced by 1/3 through the use of electronic commerce (Carter and Falush, 1997). It is hoped that by using electronic commerce, significant competitive advantages could be gained in the global reinsurance market. Information technology in the form of greater

computer support would also allow the widespread dissemination of catastrophe models, usually developed by specialist consultancies and elaborated upon in the previous chapter.

At the same time that insurers, reinsurers, and brokerages have been consolidating, the enormous losses of Hurricane Andrew and other large natural catastrophes have encouraged the development of alternative risk transfer products, referred to as ART. These products mainly feature the securitization of catastrophe risk, usually in the form of a bond. In one version, the bond pays coupons in the event no contingent catastrophe (for which the bond was issued) causes losses past a certain trigger. Once the trigger is exceeded, investors lose the bond principal and all future coupons. The securities are usually in force for about ten years, providing protection to mostly large insurance or reinsurance companies who wish to have their uppermost catastrophe layers protected in this fashion. The legal and logistical fees for securitization are comparably higher than for catastrophe reinsurance, and so while not an uncommon device, securitization remains a luxury in the marketplace. There are also a number of potential risk management problems with the securitization route that could be remedied with greater attention to liability for loss. For example, securitization contracts do not place the responsibility for the risk losses with those who bear the costs. The losses due to a hurricane, for example, would be paid by those not affected by the loss. The financial marketplace, though vast, at the same time allows an anonymous diffusion of risk and responsibility that could contribute to moral hazard problems as discussed in Chapter 1.

## Reinsurance Underwriting

The terms “catastrophe excess of loss” and “treaty reinsurance” have been referred to in the thesis. It is instructive to consider the placement of such reinsurance in the general context of forms of reinsurance, which are listed below in Figure 3.

**Figure 3: Types of reinsurance arrangements**

<b>Facultative</b>	<b>Treaty</b>
<u>Proportional</u>	<u>Proportional</u>
	Quota Share
	Surplus
	Facultative Obligatory
<u>Non-Proportional</u>	<u>Non-Proportional</u>
Excess of Loss	Event Excess of Loss
	Risk Excess of Loss
	<i>Catastrophe Excess of Loss</i>
Stop Loss	Stop Loss

The two main categories, facultative and treaty, refer to the selection of risks under contract. In facultative reinsurance, a client’s list of risks is optional to a reinsurer, who can pick and choose those which are preferably accepted. Under treaty reinsurance, the risks are reinsured in bulk with little choice for the reinsurer. In the case of proportional reinsurance, the reinsurer assumes responsibility for a percentage of the total reinsured account (i.e. premia and claims) in exchange for a ceding commission paid by the client. Proportional reinsurance thus binds the reinsurer to “follow the fortunes” of the client in premia and losses.

For non-proportional reinsurance arrangements, the client seeks protection above a certain level of losses, and so does not share the risk balance sheet. Such losses can be categorized in the contract as per event, per risk, per catastrophe, or dependent on a particular ratio of total losses to premium income. In other words, non proportional reinsurance provides the client with layered protection in return for a premium. The decision by the primary insurer on the level of retention (i.e. the amount of risk liability or level of loss it is willing to keep) with respect to its capital base is a critical indicator both of its own corporate policies and its demand and needs for reinsurance.

The type of reinsurance sought dramatically changes the expectations of loss for the primary and reinsurance companies due to the way liability contingencies are packaged legally. For example, a *risk excess of loss* contract provides separate compensation past a trigger for each risk in a particular treaty. At the same time, the risk excess faces the danger of catastrophe for the reinsurer - i.e. the danger that if all risk excess of loss properties under contract are in the same location, they could all be damaged at the *same time* through a single event. In a catastrophe excess of loss, on the other hand, the trigger follows total losses of a particular account (such as a property account of an insurer) from a single event, not from a particular risk contract. These two methods for accommodating the needs of the reinsurance client illustrate the flexibility of the reinsurance instrument and its characterization as a technology of risk (Ewald, 1991).

Proportional and excess of loss of reinsurances are often used in a complementary manner. For example, a small insurance company, in order to be able to accept a large

premium income (entailing liability) could enter into a proportional arrangement with a reinsurance company. The reinsurer would “lend its balance sheet” so to speak, and share in the premia and losses of the primary company. The insurance company could also wish to have a cap on catastrophe losses, and would seek catastrophe excess of loss for the upper layers of liability. In this manner, the transfer of risk is made in order to meet certain growth and stability targets of the primary company, trading off the costs of reinsurance with the gain in corporate objectives.

As mentioned earlier, the excess of loss contract is said to have originated in its current market form from the ingenuity of Cuthbert Heath, an underwriter at Lloyd’s during the late 19<sup>th</sup> century (Dickson, 1991). It found immediate application in relation to *catastrophe losses from a specific event*, but not from a number of events over time. After World War II, excess of loss reinsurance flourished, especially due to the widespread inclusion in insurance policies of fire, windstorm and earthquake protection. At the same time, as mentioned in Chapter 3, this growth in coverage was not accompanied by a similar growth in knowledge of the nature of natural peril risks. Indeed, the kernel of the underwriters’ routine of assessment was estimation of the fire hazard, the root of the catastrophe policy (Kunreuther and Roth, 1998).

The fire hazard was encased within a probable maximum loss estimate, a procedure which allows insurance companies to justify greater premium inflow (i.e. the PML serves as the estimate of probable loss, *not* the *total value* of the property). Catastrophes are

defined in much the same way as the fire hazard, in a temporal and spatial frame. It is

(Dickson, 1991: 7/9)

“a specific, unexpected, sudden, shocking and external happening which can be located in time and place, that is the proximate cause of each and every loss to the insureds that the company accumulates in order to make up its catastrophe claim, and that it will in itself be a peril covered by the treaty.”

Most accounts of catastrophes, however, do not go beyond the financial definition of loss.

Such thresholds of the “catastrophic” have been scaled upwards as expectations of loss have become greater over the past decade (Froot, 1999).

The excess of loss contract itself while growing in popularity after World War II, also suffered legal contention for its vague definition of various perils, notably windstorms as “meteorological disturbances.” In the 1950s, Robert Kiln, lead underwriter of the Kiln syndicate at Lloyd’s, penned a clarified wording employing time to bind the claims space of the contract in the form of an “hours clause.” In essence, “the crux of the hours clause is not the ‘catastrophe’ which is defined, but the ‘loss occurrence’ which is limited.”

(Dickson, 1991: 7/10) The hours clause thus draws boundaries for the reinsurer’s liability, and solves the difficult problem of event definition. The confusion over the former wording also involved the consultation of scientists, who contended that the atmosphere was almost always ‘disturbed.’ The hours clause solves, in other words, the conflict of ambiguous standards for scientific causality by avoiding the in-depth investigation of the event and focusing instead on the underwriter’s field of expertise, the claims space. A typical excess of loss contractual description of the hours clause is provided below in Figure 4 (Bellerose, 1998: 99-100).

#### Figure 4: Excess of loss contract “hours clause”

For the purposes of this Agreement a loss occurrence shall consist of all individual insured losses which are the direct and immediate result of the sudden violent physical operation of one and the same manifestation of an original insured peril and occur during a loss period of 72 consecutive hours as regards any

- (a) hurricane, typhoon, windstorm, rainstorm, hailstorm or tornado
- (b) earthquake, seaquake, tidal wave or volcanic eruption
- (c) fire
- (d) riot or civil commotion which occurs within the limits of one City, Town or Village  
or
- (e) 168 consecutive hours as regards all other insured perils

The catastrophe excess of loss contract allows the *client* to decide when the hours clause should enter into effect if the catastrophe occurs for a period longer than the hours clause (Bellerose, 1998: 100). Such parsing of temporal liability directly affects the financial payment combinations that can occur. Whether or not a reinsurer is liable for two claims or one can greatly affect their outflow payments to the client. A reinsurer would thus wish to minimise multiple payments in which the bands for liability are renewed, as in the implementation of a reinstatement.

For example, liability for windstorm losses is metered in blocks of 72 consecutive hours of loss. If the storm continues and recoveries wish to be made on the second 72 hours, the client must make a *separate* claim. This second claim is possible if the client has a reinstatement in the reinsurance policy, allowing for a second “blank slate” of reinsurance protection. Such reinstatements are usually offered at the time of the policy acceptance for additional premia.

## **Reinsurance Management**

Reinsurance management starts with a business development plan and the capital needed to support each class. Profit objectives by class of reinsurance are incorporated in the total decision making procedure. The state of the market, and the amount of premium to the underwriter's allocated capital base are also considered. One of the greatest financial risks a reinsurer can face is a wrong estimate of the future potential losses, expressed as a loss ratio (losses to premium income). Along these considerations, an underwriter must keep abreast of the IBNR, or the incurred but not reported claims. Indeed, the development of claims over time may take novice underwriters by surprise. An inaccurate IBNR could be just as damaging to an underwriter in future years as an inaccurate Probable Maximum Loss on a risk estimate. For catastrophe exposure from property losses, it is common for most claims to be filed within two years of the initial event. Thus some ready references exist for such policies for underwriters to assist in the IBNR estimates.

The selection of the insured is usually done along class of business and territorial lines. The evaluation of the application for reinsurance pays close attention to the financial and technical quality of the company and the history of the relationship with the client. However, the reinsurer should also be aware that reinsurance might be regarded as a means to make a profit, and that some clients will transfer to better conditions towards that aim.

## Rating Catastrophe Coverage

As elaborated previously, it is notoriously difficult to rate a catastrophe excess of loss cover based on past incidence of events. At the same time, in rating reinsurance contracts important to make a distinction among different *levels* of coverage. The upper layers of a reinsurance program contain much more ambiguity in loss occurrence probability than the lower layers. In other words, the loss trigger is much more likely on the lower layers than on edge of the high consequence, low probability tail of the probability distribution. In a risk subscription market such as London, there is an effort to recognise the layer of a particular “tranche” and to seek further reinsurance for the more extreme tranches.

Among the so called “working layers” of the contract, or those for which losses are more common from minor events, underwriters are apt to use the *burning cost* method to gauge premia. In this procedure, the underwriter estimates, using past statistics, the actual cost of all claims to the cover, adds a loading to account for brokerage, overhead, and profit, and divides this by the premium income of the company being reinsured. At the same time, the reinsurance underwriter evaluates the portfolio using proxies for the underwriting expertise and prudence of the client company. Insurance practitioner Ross Phifer (1996) described this multi-factored approach to risk assessment among underwriters (1996:119),

“Underwriting is neither an art nor a science. The judgements, whether subjective or objective, are made within a structured context. Each judgement is unique, but the thinking process and options are limited. There is an interesting mix of gut feeling and exposure analysis in each decision. Because of the guidelines and constraints, underwriting lacks the freedom of an art form. Because many parts of the process lack definition and cannot be measured with precision, it is not a science.”

Indeed, on the higher layers, no burning cost is possible due to the lack of data on past occurrences. According to Bellerose (1998: 74),

“The reinsurer relies on its own personal experience of treaties with similar characteristics and usually charges a flat premium for the whole year (which is not adjustable) or a flat rate on the gross premiums, with a minimum and deposit premium. “

The price of the layer is referred to as the *rate on line*. It is the premium charged for the coverage provided. The inverse of the rate on line is the payback. For example, for a rate on line of 5%, the payback would theoretically be 20 years. A rate of 0.2 on line would imply a catastrophe occurrence every 500 years. These methods, although not strictly “scientific” provide a guide to the underwriter in estimating and managing risk potential and expectation of loss (Bellerose, 1998). In some cases, the upper layers of a catastrophe program can be given a flat premium based on these calculations. The rate on line, or price, is naturally also subject to the level of competition in the market.

With insufficient information on the upper layers to the contract, the underwriter may use the concept of “*payback*” which estimates the probable maximum loss to be sustained by the contract covering the account concerned, and subjectively assess how often a total loss to the account under contract might occur. The underwriter then charges a rate which will generate sufficient premium income over the number of years to fund the total loss, in effect, building up a bank of reserves through premia (Dickson, 1991). This method of calculation assumes that the premium income to the annual contract will continue over a number of years and that the level of premia remains constant. Seen from a “payback” pricing perspective, the frequency of the catastrophes are therefore more damaging than

the severity of one catastrophe per se, since the method assumes a bank of premia to cover *one* total loss.

From the preceding discussion, it may be instructive at this point to provide an example of an excess of loss reinsurance “slip” providing details of the risk in question as in Figure 5 below. It could be the start of a negotiation between the broker and the underwriter as to rates and conditions, before the underwriter initials the slip indicating the percentage commitment to the contract. After the slip has been filled by the broker’s negotiations with a number of underwriters, the market document is formally processed as a legal policy (Bellerose, 1998:107). Of considerable importance is the information at the bottom of the slip concerning the losses incurred by the client in the past. Such details provide a starting point for the underwriter to query the broker as to the quality of the underwriting team of the client company and the nature of their past losses.

**Figure 5: Example of an excess of loss reinsurance slip (Bellerose, 1998: 98)**

Reinsured:	GHI Insurance Co., France
Class of Business:	Fire and Allied Perils
Territorial Limits:	France and Overseas territories
Type:	Catastrophe Excess of Loss – Third Layer
Cover:	To cover the reinsured's net retention on risks accepted by their head office in Paris
Limits:	To pay up to FF 40,000,000 ultimate net loss each and every loss in excess of: F 20,000,000 ultimate net loss each and every loss
Reinstatement:	Two full reinstatements, first at 100% additional premium, second at 50% additional premium, both pro-rata as to amount reinstated only.
Rate:	0.15%
Minimum and Deposit Premium:	FF200,000 payable half-yearly in advance
Period:	Losses occurring during the period of 12 months at 1 <sup>st</sup> January 1996
Conditions:	(1) Ultimate net loss clause (2) Net retained lines (3) Excess of Loss treaty reinsurance exclusion (4) Hours clause
Brokerage:	10%
Information:	Estimated gross premium income 1996 F 160 million No losses exceeding FF 20,000,000 Largest loss ever was in 1994 – F 8,750,000 Maximum Retention of Reinsured any one Risk FF 2,000,000

Seen in conjunction with Figure 5, Figure 6 below presents an aide-mémoire of underwriting assessment. The considerations therein could be framed in terms of weight of argument. Moreover, the answers to these types of questions indicate that a judgment formation within a causal field of underwriting and market practices is being assumed. Most of the questions below consider the generation of expectation within a class or threshold of loss experience.

**Figure 6: Questions a reinsurance underwriter might ask when evaluating a contract** (Bellerose, 1998: 118)

Do the loss figures represent the probable final cost of a claim? Do the past results conform to the results which are normal for that type of business? If not, why not?

To what extent will changes in portfolio change the pattern of the past results? How would inflation have affected the result? To what extent have fluctuations in currency affected the results? To what extent have fluctuations in premium income affected the results? What would have been the effect of an extraordinary claim on the results? What would be the effect on the results of an unforeseen deterioration?

What is the likelihood of a catastrophe affecting the cover? What are these catastrophes? How much loading should be built into the rate for such an eventuality?

What is the general experience of the type of business covered? What effect would a change in legislation have on the type of business covered?

In addition to these questions, the underwriter would judge the value of continuity, or continued relations with the client and the broker. The competition in reinsurance thus focuses not only on rates, but security, continuity, commission, and specific terms and conditions on individual classes of business. Therefore, the costs of seeking reinsurance and that of brokerage (i.e. brokers charge commission for their services to underwriters) bind the underwriter's freedom of acceptance.

### **Context of Underwriting Within the Firm**

The extent of the information search by the underwriter will depend on cost, trouble, relevancy and time (Holtom, 1987). For example, the experienced underwriter is marked by the ease of recognition of relevant information, and the decision to curtail investigation when the search for more information will not shed new light on the

assessment. Therefore, relevancy assumes a critical role. Moreover, the reliability of the information is a critical part of the underwriting decision making process. The sources include the broker's report, public records or previous insurance reports. This information creates a set of alternatives to the underwriter in terms of setting premium rates, determining policy conditions, and applying for reinsurance. As underwriters become more experienced, the routine of information against a particular causal field produces a recognition of relevance and perceived omission in the process of negotiation, weighted assessment, and selection. Underwriting practitioner Robert Holtom (1987: 82) cautions however that

“Under any system, the underwriter must watch for circumstances or peculiarities that appear to be insignificant upon a quick glance but may present real problems when all of the facts are known.”

Naturally, the preceding is disposed by the underwriter's assumptions of what can be known, and whether or not it can be known in a usable form. Moreover, the risk market plays a large role in underwriting decision making, and must be included in the causal framework of the underwriter. This framework is informed by personal experience but also depends on the *personality* of the underwriter, the ability to recognize cues in the market, and to remain even headed. It concerns the degree to which an underwriter is comfortable in making decisions on catastrophe risk based on limited information.

While the underwriter in the London market and especially at Lloyd's has been described as operating on a relatively independent basis, there are pressures from other departments

within the reinsurance company which shape the underwriters' goals and objectives.

These other core departments comprise actuarial, claims, and sales. Often the underwriting department is more risk seeking than the conservative actuarial section or the administrative claims department. Underwriters could consider actuarial tendencies restricting, sales demands overbearing and claims administration banal. Conflicts may arise between underwriters and sales departments, for example, over market share and risk acceptance. Alternatively, corporate clients disposed to preferential rates may place the underwriter in potential conflict with the actuarial management.

The late Robert Kiln, a lead underwriter for the Kiln syndicate, advised on the characteristics of a good underwriter. The former chief executive remarked that one needs five qualities (Kiln, 1991), listed below in Figure 7. The first three character traits refer to the ability to package risk contracts and to make decisions quickly, while the last two point to the importance of probity and relationship continuity in the risk market.

**Figure 7: The five qualities of the reinsurance underwriter (Kiln, 1991: 397)**

**Firstly.** A quick mathematical mind; the ability to do mental arithmetic fast - a cross between a barrow boy and an actuary!

**Secondly.** Ability to foresee future trends and calculate probabilities - a cross between a bookie and a gypsy!

**Thirdly.** The ability to regard it all as a game and the personality to enjoy taking decisions and move on to the next without worrying - a good bridge or poker player.

**Fourthly.** A good factual memory, patience and the ability to assess people's integrity - a psychological computer.

**Fifthly.** Integrity.

## **Conclusion**

This chapter provided an overview of the structure and function of the London market and Lloyd's. It then took the perspective of the individual underwriter in reinsurance management and assessment. The parsing of liability among reinsurers and their clients is the modus operandi of the reinsurance marketplace, continuing the discussion in Chapter 1 on the flows of information in reinsurance. The claims space is also linked to the risk market in terms of continuity considerations, the dependency upon brokerages for business, and the density of risk competitors. The risk market is a fluid enterprise in which traditional market practices form a critical base for the tacit knowledge of risk assessment, underwriting, and turning profit out of risk protection.

The embedded routines of reinsurance assessment and artifacts of underwriting have not been reflected in the economic literature on decision making under uncertainty. In the next chapter, an overview of this literature is given, and comparisons are made between the theoretical and the more empirically informed characterization of underwriting in Chapters 6 and 7.

## **CHAPTER 5**

### **Decision Making under Uncertainty**

## **Introduction**

While the previous chapter described some of the artifacts of underwriting within the context of the London market, this chapter will once again move into theoretical waters. It discusses the two main perspectives in the economic literature on decision making under uncertainty, that of deductive and mathematically based frameworks of expected utility, and that of inductively informed decision tendencies derived from controlled behavioral decision experiments. As a point of common departure, both the behavioral and the axiomatic adhere to overall positivist criteria of theory building and models as expressions of decision making. However, for the most part there is neglect of a definition of probability and an omission of causality from the decision making framework. Risk and uncertainty are grounded in metaphors of marbles in urns - an a priori distribution of outcomes that does not correspond to natural decision contexts.

Taking the dominant gambling analogy in the decision literature, risk is often referred to as a known probability distribution, uncertainty as lack of information on probabilities of known outcomes, and ignorance as absence of knowledge on either probabilities or outcomes. The chapter illustrates that the decision making literature, particularly the behavioral authors, have recognized the impasse of purely probability based studies. Several recent articles have pointed to the importance of causality in the contextualization of uncertainty. This chapter, in addition to chapter 2, provides another building block towards a geography of risk, that of decision making under uncertainty.

## **The Two Sides to Uncertainty**

The economic literature on decision making under “uncertainty” consists of two main contending schools: one of rational choice, expected utility (EU), subjective expected utility and axiomatic deduction; and one of behavioral theory and prospect theory. The two schools differ in their academic orientation. The former is dominated by mathematical and logic economists, creating in economist Joseph Schumpeter’s view “a logic of choice rather than a theory of value” (Kahneman and Tversky, 1986: 67), while the latter consists of mostly psychologists, cognitive scientists, and management researchers.

The rational choice paradigm provides economists with a unifying, unequivocal standard of economic behavior. This decision making frame focuses on decision outcomes (i.e. results) as indices of rationality rather than processes of judgment. The main reason for this selection lies in the rational choice epistemology as mathematical, axiomatic and deductive. Much of the psychological contributions to decision theory, on the other hand, are based on controlled decision experiments and thus represent an inductive, empirical approach towards the elucidation of decision processes. A unifying theory in the behavioral literature does not exist; rather the focus has been on identifying and characterizing a pattern of findings from decision experiments. Such results are often found to challenge the predictions of rational choice theory and are indeed motivated to display contraventions to expected utility assumptions.

Certain metaphors wield considerable influence in the behavioral model, aligning

approaches and shaping arguments. These include the portrayal of decisions as a selection among prospects, decision behavior as represented by attitudes towards probability distributions in urns, human cognition operating like a computer, and error producing tendencies similar to mirages in visual perception. While heuristically useful, these metaphors may contribute to the similarly limited representations of reality as expected utility, by guiding thought along certain mental landscapes of decision reality.

### **Expected Utility and Rational Choice Theory**

Rational choice has origins as a mathematical theory (von Neumann and Morgenstern, 1944). As internally consistent, coherent, and logical, the theory provides a stable foundation for the discussion and solution of a number of decision problems. The von Neumann-Morgenstern account of rational behavior is based on expected utility, itself founded on mathematician Daniel Bernoulli's concept of expected value (1739). The decision problem consists of rarified aspects of the decision situation: the decision maker's preferences, subject to a budget constraint, and the options available to the decision maker, expressed in probabilist terms of risk (i.e. probabilities and consequences), with the combination being the expected utility. This expression of decision making is shown in Figure 8 below. D.M. refers to the decision maker, who is assumed isolated and having complete knowledge of all available options. The prospects are placed in monetary units for convenience of a comparison of utility. DM can either take \$600 with a probability of 90%, or \$1000 with a probability of 30%.

**Figure 8: Simple representation of a rational choice problem**

D.M.	_____	.9	_____	\$600	expected utility presented in dollar units = \$540
	_____	.3	_____	\$1000	expected utility presented in dollar units = \$300

The expected utility of the first option is \$540, while the second is only \$300. The rational decision maker would choose the first option, since it maximizes expected utility. There are a number of constraints that could be placed on this simple example to add further dimensions of complexity. Indeed, one could even provide a multi - attribute preference function (which could factor in the conditions of the decision maker to a much greater extent) which could then be solved algorithmically for maximizing expected value.

The economic description of behaviour is to assume that an individual decision maker behaves as if solving a constrained maximization problem for commodity quantities that can be varied. Aggregate decisions (for example over a few persons in a group) are assumed to follow a simple summation of individual isolated maximization decisions. The expected utility framework formalizes decisions as in the insurance literature and formula (1) in Chapter 2.

A modification to the expected utility theory is the subjective perception of probability by the decision maker. Under *subjective* expected utility (Savage, 1954), the axioms of expected utility still hold,<sup>35</sup> and are subject to the same maximization criteria as expected

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<sup>35</sup> As mentioned in Chapter 2, Keynes declined to recognize subjective probability as amenable to rationality.

utility. Again, the nature of the decision problem is *probabilist* and *comparative*. It is the comparative nature that requires the assumption of consistency be maintained for rationality to hold. In charting these “subjective” waters, Savage takes from Ramsey (1926) in that subjective probabilities can be *inferred* mathematically from the decision maker in the form of a wager. Thus, individual logical consistency in subjective probabilities can be guaranteed, making this framework a candidate for rational choice axiomatization (Hogarth and Goldstein, 1997).

The four main assumptions underlying the axiomatic treatment of expected utility and subjective expected utility are listed below in Figure 9. They provide the girdle for the mathematical treatment of utility maximization. As will be discussed, these axioms are contravened by the psychological experiments of the behavioralists. In the face of these results, the axioms reveal their essentially mathematical and logical character.

### **Figure 9: Assumptions underlying the axiomatic treatment of expected utility**

#### **Cancellation**

Choice among options only depends on the state of the world. Therefore in making a choice, the decision maker would eliminate any state of the world that would yield the same outcome regardless of one’s choice. In other words, only one state of the world will be realized, therefore options should be compared across states of the world.

Example: If A is preferred to B in state of the world X, then A is preferred to B in any state of the world which is not affected by A or B. If a decision maker prefers ice cream (A) to a candy bar (B) on a sunny day (X), then he/she would prefer ice cream to a candy bar on a rainy day.

#### **Transitivity of Preference**

Evaluation of options are transitive, i.e. if the utility of A,  $u(A)$ , is preferred to  $u(B)$ , and  $u(B)$  to  $u(D)$ , then  $u(A)$  is preferred to  $u(D)$ . Options are evaluated separately (the utility of one option does not depend on the alternative to which it is being compared).

Example: A is preferred to B if on the ordinal scale  $u(A) > u(B)$ . If the decision maker prefers the enjoyment of an ice cream to movie, and a movie to ice hockey match, then he/she would prefer an ice cream to an ice hockey match absolutely.

### **Dominance**

If in one state, one option is preferable to all other alternatives and is at least as good an option in other states, then this option should be chosen.

Example: If the highest set of payoffs in one state is 60 units, and in all other states the payoff is at most 60 units, then that payoff should be chosen.

### **Invariance**

Among different alternatives, preference for one should be independent of the description of the choice set. Choices are independent of psychological appeals to descriptions of options that do not alter their outcomes.

Example: Preference for one of three different commodities - a tie, an ice cream, and a vacation, is not affected by different marketing techniques of the same products.

These assumptions (including two further technical assumptions of comparability and continuity) correspond to the structure of mathematics itself. The main criticism from behavioral researchers is that although internally consistent and tractable, the theory sacrifices too much in terms of *correspondence to reality*. Still holding rationality as a barometer of human decision, behaviorists decry the rational choice focus on substantive rationality, or the rationality of outcomes, while neglecting procedural rationality, or the rationality of the decision process. In addition, many assumptions of rational choice have been contravened in decision experiments, and epitomized in the two examples below (Tversky and Kahneman, 1986).<sup>36</sup>

The Ellsberg and Allais paradoxes – seen as paradoxes in the eyes of expected utility - are

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<sup>36</sup> Invariance and dominance have been considered especially essential, but even these pillars have proved unwieldy foundation stones when challenged in particular decision experiments.

considered critical anchors in the behavioralists' position. The paradoxes consist of rational choice type problems, but reveal the effects of ordering, framing, and loss levels to influence decision outcomes. In the first example below, the Ellsberg paradox, ambiguity as a variant of risk refers to an unknown number of probability distributions, while risk refers to exactly one probability distribution.

**Example 1: Ellsberg paradox (Ellsberg, 1961)**

Two urns each contain red and black balls. Urn 1 has 100 balls with unknown proportions of red and black. Urn 2 has 50 red and 50 black balls.

Consider the following gamble:

- if you bet on red and it is drawn from the urn you receive \$100 payoff, otherwise \$0
- similarly for black

Consider Urn 1: most people are indifferent to betting on a red or black ball (designated by R.1 and B.1) implying that the subjective probabilities are equal, i.e.  $p(R.1) = p(B.1) = 0.5$ . For Urn 2 this condition is similar, implying for most people,  $p(R.2) = p(B.2) = 0.5$

Imagine that you are asked whether you prefer to draw a red ball from Urn 1 or Urn 2. Most people in this situation prefer to draw from Urn 2, with a known proportion of black to red, then from Urn 1. Ellsberg argues that this behaviour implies  $p(R.2) > p(R.1)$ . However, from the previous choices,  $R.2 = R.1 = 0.5$ . Therefore, there exists a contradiction between the probabilities inferred from choices concerning each Urn separately and those concerning choices between Urns. The same case is true if one was asked in the two cases about preference for choosing black. If taken to its logical conclusion, these preferences mean that in adding the probabilities of the two cases,  $p(R.2) + p(B.2) > 1$ , and conversely for the sum of  $p(R.1) + p(B.1) < 1$ . Nonadditivity of complementary probabilities is a common feature of judgments under ambiguity and violates subjective expected utility (Camerer and Weber, 1992: 328).

The Ellsberg paradox exposed the *descriptive* invalidity of subjective expected utility in simple gambles (Anand, 1993). The paradox also pointed to the importance of factoring incomplete information, or knowledge, into the degree of ambiguity aversion by decision

makers (recall that ambiguity in this case corresponds to multiple possible distributions, risk being a single distribution). Formally, the paradox contravened an assumption of Savage's subjective axiomatization by violating independence.

Example 2 forms another pillar of the behavioralists, the Allais paradox. Allais proposed the following hypothetical decision situation:

**Example 2: Allais paradox (Allais, 1953)**

Situation X	Amount	Probability
Option 1	\$1,000	1.00
Option 2	\$1,000	.89
	\$5,000	.10
	\$0	.01

Situation Y	Amount	Probability
Option 3	\$1,000	.11
	\$0	.89
Option 4	\$5,000	.10
	\$0	.90

Asked to choose an Option in situation X and an Option in situation Y, most respondents were inclined to choose option 1 in situation X and option 4 in situation Y. In situation X, the certainty of winning \$1000 in Option 1 was more appealing than the chance of winning \$5000 in Option 2. In situation Y, the decision makers reasoned that the probability differences are small, so they would wish to risk the larger amount. The Allais paradox displays the tendencies of decision makers, even within the decision framework of expected utility theory, to violate the axiom of independence. Moreover, it reveals that decision makers may be influenced by perceptual considerations to overweight the impact of low probabilities.

**Why Has Rational Choice Persisted as the Dominant Paradigm?**

While not descriptively valid, the rational choice paradigm has been enormously influential in the economic literature. One reason for its popularity could be the desire of

economics to emulate the natural sciences, most notably physics, in its description of initial conditions and tractable control of processes. However, while physics has moved from a Newtonian paradigm to one based on indeterminism and indeed uncertainty, economics remains wedded to deterministic frameworks and the search for generalizable laws of human behavior (Giarini and Stahel, 1992).<sup>37</sup> One might say there is a difference between the goals of economic theory (emulation of scientific theory building, the emphasis on models with greater predictability, the accolade upon “discipline” in creating theories of sophistication, elegance and tractability, and the regular application of Occam’s razor) and the goals of description of actual human behavior (recognition of multiple variables, context dependencies, psychological predispositions).

While the behavioralists remain intent on inferences from experimental evidence to challenge expected utility, economist Herbert Simon provided another classification of decision making behavior: satisficing.

### **Bounded Rationality and Simon’s Satisficing Behavior**

“Economics without the psychological and sociological research to determine the givens of the decision making situation, the focus of attention, the problem representation, and the processes used to identify alternatives, estimate consequences, and choose among possibilities - such economics is a one bladed scissors. Let us replace it with an instrument capable of cutting through our ignorance about human rational behavior.” (Simon, 1986: 40)

According to mathematical economist Herbert Simon (briefly encountered in Chapter 3),

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<sup>37</sup> At the turn of the 20<sup>th</sup> century, Keynes remarked that Benthamite calculus employed in economics courted disappointment, since the relations for which economics seeks to provide covering laws are not stable over time (Lawson, 1985).

“Contemporary neoclassical economics provides no theoretical basis for specifying the shape and content of the utility function...” (1986: 29). While Simon approves the positivist epistemology of economic decision making as well as the methodology of mathematical logic, Simon offers (within this same domain) an alternative account of rationality. He takes a computer processing analogy to defend his thesis that human decision makers, while striving to maximize utility, are restricted by cognitive limitations and short timeframes. In other words, decision makers do not know all possible options in a decision context, but rather follow a ‘bounded’ rationality - one that makes ‘satisficing’ decisions. This decision procedure meets criteria of reasonableness based on available knowledge and means of computation. Simon thus supports broader accounts of decision making than that provided by expected utility. He criticizes the neoclassical approach as invariant across decision situations and as neglecting the nature of goals and values.

Simon broadens the themes of decision making by remarking that while rationality in economics focuses on the outcome of choices, rationality in other social sciences, notably psychology, emphasizes the processes employed. In the former case, quantifiable and generalizable laws of behavior are sought. In the latter case, situation specific variables give rise to decision situations. The Nobel laureate emphasizes the nature of the emergence of choice to the decision maker, particularly the effects of framing and the subjective, contextual representation of the choice situation.

While acknowledging the difficulties of empirical research on decision making, Simon nevertheless supports *ethnographic* research of “these processes directly while they are

going on, either in real world situations or in the laboratory, and/or interrogating the decision maker about beliefs, expectations, and methods of calculation and reasoning.” (1986: 27) This thesis uses an ethnographic approach to describing catastrophe risk decision making in the City to highlight the context and categories of decision making processes. Simon’s approach thus takes the nature of the empirical as allowing a contextualization of the human condition in decision making. Elements of attention, perception, and cognitive processing provide the matrix for a reality based on interpretation and reaction, not global consistency of behavior.

### **The Controlled Experiments of Kahneman and Tversky**

Despite Simon’s doubts as to the fruitfulness of decision experiments to reveal the context of choice, much of the work performed on procedural rationality has been conducted employing this methodology within a positivist epistemology. The centerpiece of psychological findings on decision making, prospect theory, owes its motivations to defying the assumptions of subjective expected utility. The fact that prospect theory was first published in the journal *Econometrica* (1979) belies the motivation to win over economists within their own “model building” positivist paradigm and within the verification of knowledge in the form of a mathematical function.

The foundations of prospect theory are based on a series of controlled decision experiments involving sets of comparisons among prospects (in other words, among expected values). Psychologists Daniel Kahneman and Amos Tversky sought to display, in as much a form that economists would recognize, that decisions are shaped very much

by perception and especially by comparison among options. For example, Bernoulli (the founder of expected value) viewed financial gains or losses as viewed against the *total* wealth of the individual. Kahneman and Tversky concluded from their decision experiments that each gain or loss is evaluated on its own, not as an addition to total wealth. Such reference points underlie many decision judgments, the behavioralists contend, which they refer to as the “isolation effect.” (Baron, 1988) Another finding points to the influence of framing the prospect as a gain or a loss in the decision makers outcomes, thus battering the invariance assumption of expected utility. Indeed, Kahneman and Tversky found that decision makers become risk seeking when their options are displayed as losses, and risk averse when they are displayed as gains. This behavior was referred to as the “reflection effect.”

Through a number of such experiments, Kahneman and Tversky integrated their results to argue that the total value of a prospect represented by probability  $p$  and outcome  $x$  is actually a combination of a decision weight,  $\Pi(p)$  (a function of its probability) and a valuation of the outcome,  $v(x)$  (affected by the framing of the prospect). The decision maker's attitudes towards risk are therefore influenced by  $\Pi$  and  $v$  and not simply expected value, as in rational choice theory.

The authors proposed a two-stage decision making process: editing/framing and evaluation. The first concerns the influence of the decision weights, while the latter focuses on the value function. In the editing phase, decision makers code the prospects as gains or losses relative to a reference point. Kahneman and Tversky (1979) stated that the

same prospect would be subject to different edited forms, depending on the context and framing of the prospect as a gain or as a loss. In the second stage, the evaluation phase, the decision maker ranks the prospect on two scales: a decision weight,  $\pi$ , related to the probability, and a subjective evaluation of the outcome,  $v$ , which measures gains and losses relative to a reference point. According to the authors, the decision weight “measures the impact of events on the desirability of prospects, and not merely the perceived likelihood of these events.” (Kahneman and Tversky, 1979: 280) Thus, although *related* to probability, the decision weight is not formally a subjective probability in Ramsey’s sense. More precisely, it is “the ratio of the weight associated with the probability  $p$  to the weight associated with the certain event.” (Kahneman and Tversky, 1979: 280)

Using an analogy from human perception, Kahneman and Tversky proposed that differences in value from a specific reference point, as opposed to absolute values as assumed in expected utility, play a central role in decision making. They mentioned that as the eye views differences in the lengths of identical lines placed to form an optical illusion, so the decision maker is influenced by the reference and framing of decision prospects.

Formally graphed, prospect theory’s outcome value function,  $v(x)$  (derived from the the patterns observed in decision experiments) exhibits concavity for gains and convexity for losses, with the losses being steeper than the gains. The graph thus pictorially represents the decision maker as more likely to experience a greater decrease in utility for a loss than

an increase in utility for a corresponding gain. Moreover, these differences in value are not correlated with subjective probability, but rather on the decision weight  $\Pi(p)$ , the ratio of the weight associated with the probability  $p$  to the weight associated with the certain event. The experiments suggested that decision weights were lower than corresponding probabilities<sup>38</sup> except in the range of low probabilities, where they were higher. In other words, subjects usually underweighted prospects with high probabilities and overweighted prospects with low probabilities.

Interestingly, the authors also mentioned that decision weights could be applied to those events with no specific probabilities, such as could be argued for catastrophe risk. In such cases, the decision weights should be applied *to the events themselves*.  $\Pi$  would reflect the perceived likelihood of the event, and could be affected by bias, ambiguity, or vagueness (Kahneman and Tversky, 1979: 285).<sup>39</sup> In an revised version of prospect theory (Kahneman and Tversky, 1992) in which decision weights become cumulative, another “reflection effect” was observed in prospects involving high or low probabilities. With prospects involving high probabilities, much of the same decision behavior was observed as in the original prospect theory (1979). However, for those prospects featuring low probabilities, a significant shift in behavior was observed. In the face of low probabilities, the results displayed risk seeking for gains and risk aversion for losses, the opposite finding of the original prospect theory.

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<sup>38</sup> The probabilities are taken to mean objective probabilities, the decision weights being a perceptual weight attached to the probability by the decision maker.

Kahneman and Tversky investigated these new results with surveys of individuals concerning their risk perception of the frequency of adverse events. Many respondents overestimated rare events, such as a plane crash, and underestimated more familiar risks, such as a car accident. This estimation was found to be influenced by exposure to such events, e.g. through the popular media, personal experience, or discourse – an influence referred to as availability. Similar experiments suggested that people tend to regard the occurrence of independent events as having a memory, i.e. the probability that a die displays a six five times influences the occurrence a sixth time. This error has been referred to as the gambler's fallacy.

Furthering the work of Kahneman and Tversky, business researchers Robin Hogarth and Hillel Einhorn (1986) investigated decision making under a probability *range* (i.e. not point probabilities, as in prospect theory), and found that people tended to anchor beliefs on a particular probability and to make adjustments based on new information. This finding is consistent with Baron's (1988) research into decision making and argumentation, which suggests that prior beliefs tend to bias the decision frame of most decision makers, who often do not consider alternative arguments. Several of the main findings from prospect theory and other behavioralist decision research are listed in Table 8. They are amenable to a description of catastrophe risk decision making and reinsurance, as will be discussed in Chapter 7.

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<sup>39</sup> It is arguable whether or not these special decision weights are comparable to Keynes' concept of weight or to Ramsey's betting method deriving a subjective probability.

**Table 8: Tendencies found among results from decision experiments**

<b>Tendency</b>	<b>Description of Behavior</b>
Certainty Effect	Prefer certain outcomes to probable outcomes, except in the domain of losses
Reflection Effect	Switch risk seeking to risk averse behavior depending if losses or gains are presented
Isolation Effect	Decisions focus on the incremental gain or loss, not taking into account total wealth
Framing	Depending on the presentation of the prospect as a gain or a loss, different behavior is observed
Anchoring and Adjustment	Initial beliefs anchored on a particular probability, making only minor adjustments thereafter
Gambler's Fallacy	Tendency to attach a memory to independent events
Availability	Tendency to attribute personal perception as objective probability of event occurrence
Sunk Cost Effect	Tendency to keep with loss making decisions since substantial resources have already been committed
Regret	Tendency to make decisions to avoid regret if such options bring big payoffs

### **A View from the Ring Side**

Public policy economist Richard Zeckhauser likened the debate between rational choice economists and decision making behavioralists as a battle between “religious” rather than scientific theories. He contended that each side, based on a firm belief that their approach is the correct one, protects a certain academic territory from which it seeks to expand. A self-professed moderate in the fray, Zeckhauser offered the following advice, using the criteria of predictability between competing theories (Zeckhauser, 1986: 251),

“Behavioralists should perform experiments on choice patterns with realistic implications while Rationalists should delineate the areas in which the evidence overwhelmingly supports the theory. Choice among elegant, abstract, but conflicting propositions should be based only on the consistency of their predictions with real world observations.”

One might ask if such a comparison is valid, i.e. if behavioral theory is a theory in the sense that expected utility is a theory? Behavioral economist Richard Thaler raises the objection of the rationalists that behavioral theory does not contain normative assumptions, it is a descriptive theory only (Thaler, in Hogarth and Einhorn 1986: 97).

The differentiating criteria hinges upon their respective epistemologies: descriptive theories are based on inductive principles, while rational choice is deductive from a priori axioms. Therefore, one cannot develop both theories along the same theoretical lines.

Such divergence may be one problem in the miscommunication between the two groups – they seek different criteria for knowledge and theory building with which to model reality. Perhaps convergence will never occur due to the divergent premises of their goals, arguments, and research agendas.

According to human geographer R.J. Johnston (1983) (encountered in Chapter 3) an important distinguishing criterium among theories relate to their epistemology and ontology. Both refer to assumptions behind knowledge creation. Epistemology answers the question “how can we know it” - in the case of rational choice, it is through deductive, axiomatic operations. Ontology, while closely related to epistemology, importantly discriminates between the approach to knowledge and the acknowledgment of what can be known. Therefore, ontology underscores the assumptions of epistemology in the weaving of theory tapestry, depending on what can in fact be in the images. It could be postulated that rational choice and behavioral theory have different epistemologies in terms of method and object of research but rather similar positivist ontologies, that

universalisable tendencies can be observed in human behavior and mapped onto a mathematical function for predictive purposes.

The inductive epistemology and controlled experimental approach of behavioral theory also has its critics. Does it suggest that human decision behavior (universal modes of behavior, as in economics) follow certain systematic tendencies? Some critics point to the lack of applicability of prospect theory in more complex, natural decision environments. They argue that as prospect theory is mostly a theory of *perception*, not of *epistemology*, the role of knowledge in decisions is not the starting point of the investigation. Knowledge is not treated at all in much of the behaviorist literature, save a few studies of perceptions of self - competence under unknown probabilities (Heath and Tversky, 1991).<sup>40</sup> Others mention that the search for error and irrationality are normative considerations which cloud studies of descriptive behavior as it is. A behavioral cataloguing of experimental decision tendencies does not address the roots of human judgments.

Philosopher Nils-Eric Sahlin (1991) questions the descriptive approach of prospect theory and the corpus of the behavioral decision making literature to provide anything more than a collection of observations. Although he acknowledges that the inductive strategy may supply models for prediction, such an epistemology will not generate explanation or more profound understanding of the underlying phenomena or especially an analysis of causation (Sahlin, 1991: 431). He states that expected utility is prescriptive in aim rather

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<sup>40</sup> Still to be addressed is the role of fluid identity formation through decisions.

than seeking a theory of human cognition (1991: 446) and therefore a wrong place from which to start, or frame the behaviorist research. Sahlin remarks “To go from probability measures to weighting functions, and from utility measures to value functions, does not add much of explanatory power to our descriptive theory.” The philosopher of mind advocates a theory of belief (1991:444) requiring an experimental design to inform on the cognitive maps of decision makers. Sahlin’s critique rests on the importance of theory as *explanation*, which in the economic literature has been superseded by the dominance of *predictive* considerations. Sahlin also wonders why other options, such as causal decision theories (Gardenfors and Sahlin, 1988), have received such scant attention.

### **The Broader Context of Uncertainty and Ambiguity**

The behavioral literature has been greatly influenced in its foundations by the application of probability and utility to particular thought experiments, usually involving the selection of colored marbles from urns. Part of the reason for the early focus on decision under a priori distributions is attributable to the emphasis on *probability* in the economic theories of rational choice. Moreover, probability as defined with reference to games of chance, i.e. a priori probability, has natural application to experimental prospects. Increasingly, behavioral researchers have begun to question the fruitfulness of the gambling metaphor and the adherence to ready-made, measurable decision experiments as simulating appreciable decision contexts (Camerer and Weber, 1992; Hogarth and Kunreuther, 1995; Hogarth and Reder, 1986; Sahlin, 1991; Lopes, 1991; Huber, 1997; Cohen, 1981). Decision making contexts rarely involve selection from a knowable distribution of

outcomes, although the studies using urns were mostly concerned with challenging the expected utility theory. Behavioralists Camerer and Weber, in their review of the behavioral decision making literature, proposed future research to heed less the pull to frame the study using urns and instead to elaborate on “broader domains of missing information and competence.” (Camerer and Weber, 1992)

How can the transition be effected? One approach has been to propose a concept of *ambiguity*, defined as uncertainty about the level of uncertainty (as in the Ellsberg paradox). Einhorn and Hogarth (1986) use ambiguity to describe three elements that characterize risky decision making and which utility theory fails to include. These comprise (1) the nature of uncertainty in choice, (2) the effects of context, and (3) the dependence between probabilities and payoffs.

The argument of (1) is that the popular metaphor used to conceptualize risky decision making emphasizes choices between explicit gambles. By contrast, human perception of uncertainty in real world situations is subject to greater complexity. (2) recognizes that the gambling metaphor, although providing a clear scaffolding for decision making studies, is only specific to that framework, thus biasing the evaluation of risk. The third element claims that contrary to the popular assumption that utilities and probabilities combine independently to create the value of outcomes, the payoffs themselves can systematically alter the perception of uncertainty, especially under conditions of ambiguity. However, in defining ambiguity Einhorn and Hogarth again refer to the analogy of the distribution of colored marbles in urns. Ambiguity in the decision situation

refers to information that certain distributions can be ruled out, while uncertainty refers to an infinite number of possible distributions (risk is taken as exactly one probability distribution). Thus “knowledge” and probability in behavioralist decision research cling to the foundations of urns and a priori, fixed probability distributions.

While ambiguity was introduced to serve as the middle ground between risk (one probability distribution) and uncertainty (infinite possible probability distributions), it too suffers from a gaggle of interpretations. In addition to representing a medium number of probability distributions in an assessment of fixed, but unknown probability distributions, ambiguity also refers to a second order probability, one indicating the judgment of an “objective” first order probability (as in Sahlin’s example). Einhorn and Hogarth define ambiguity by reference to the amount of information known, the congruence and reliability of the information, and the level of knowledge about the causal processes producing certain outcomes. As these decrease, ambiguity increases. In line with this view, Camerer and Weber note that ambiguity is “uncertainty about probability, *created by missing information* that is relevant and could be known” (Camerer and Weber, 1992).

Much of the literature on decision making under ambiguity has been inspired by the Ellsberg paradox and its reflection upon the role of knowledge. Camerer and Weber (1992) point to Keynes’ distinction between the implications of evidence (i.e. probability) and the weight of evidence (total relevant information) when assessing arguments. It is doubtful whether one measure, probability, could serve as an indication of both, even with a second order function. Anand (1993) for example suggests an epistemic measure

of information quality and quantity, in addition to the probability calculus. Indeed, both the axiomatic and the behavioral studies do not distinguish among the probabilities used in rational choice situations, other than they are either objective or subjective. A frequency based probability and a degree of belief probability has yet to be compared in this literature, which takes many longstanding problem frameworks as givens without delving into their origins as different types of knowledge categories.

Ambiguity could also be taken to mean a lack of consensus among experts, creating a context in which opinion, or the older form of the “probable” (as belief of high ranking experts (Hacking, 1975)) exists. Indeed, the range of expert opinion in the climate change debate has heightened the recognition of ambiguity among assessments. On the other hand, ambiguity could also refer to the *identification of the decision situation* by the decision maker. Such an omission by the behavioralists of ambiguity as meaning the construction of the situation is understandable, considering that most of their results occur in controlled, pre-fixed explicit prospects resembling gambles. However, as more researchers delve into a study of natural decision contexts, more objections are voiced concerning the narrow pillar of gambling metaphors.

Huber and Kuehberger (1996), for example, found gambling tasks to differ systematically from naturalistic decision tasks in the cognitive representation of the decision situation, the components of the decision process, and the role of subjective probabilities. Indeed, in concurrence with Einhorn and Hogarth, Huber (1997) stated,

“The difference between gambles and bets and naturalistic tasks can be summarised by stating that naturalistic decision tasks are ill-structured problems in knowledge-rich domains, where causal relations and attributions and the decision maker’s control beliefs are relevant.”

Huber and Kuehberger point to the importance of causal perception and the relevance of the management literature. By focusing on the perception of the individual within institutional contexts, such research on corporate decision making has shown that subjective risk is framed by more than simply subjective probability and the utility of outcomes, i.e. prospects. Indeed, in many cases the decision maker must structure his or her own decision situation. Decision experiments also do not consider the background knowledge of the decision maker. Finally, in experimental contexts, the decision maker often has no control once the decision has been made, which contrasts sharply with organizational decisions in which individuals are faced with not just one decision, but decisions in a web of decisions over time, by different parties and with different role responsibilities. Information search and problem *structuration* is a much more reflective and active process.

Huber (1997) concluded that utilities and subjective probabilities do not capture the essence of the realistic decision situation. Consequently, probability biases as discussed earlier do not play much of a role, especially in decisions not involving probability. He likened the decision making process to one of problem solving. The upshot for decision research, Huber stated, is that “Risky decision theory should therefore focus attention also on biases in causal judgments and control estimations.”(Huber, 1997: 160) He advocated decision support systems that encourage the decision maker to generate a representation

of the situation, including its causal structure.

In Huber's own empirical research, subjects were found to attempt to exert control over possible negative outcomes by three "defusing methods": controlling the occurrence of the negative event, interrupting the causal chain between the event and the negative consequences, and designing a worst case plan.<sup>41</sup> However, Huber's work did not address the potential for decisions to be representatives of both positive and negative results, and neglected to highlight how decisions are mediated through their perceived consequences (both from memory and as projection) to produce impressions of causal connections.

Decision researchers and psychologists Teigen and Brun (1997) consider personality dispositions and situational characteristics in their work. Expectation, they argue, is essentially derived from either past analogies in the form of statistics, or future projections using causal links (Teigen and Brun, 122). They point to studies indicating that under uncertainty, decision makers perform mental simulations. Indeed, Kahneman and Tversky (1982) found such "simulation heuristics" common. These mental constructions enable a psychological sense of possible realities, a theme repeated in organizational theorist Karl Weick's work (1995).

Teigen and Brun suggest that it would be more fruitful to investigate the larger context of subjects' psychological reality than subjective probability values, however the two may be correlated. They pay special attention to causal attribution, since "causes may forge the

links between the future focal event and the ‘already real’ past and present parts of the puzzle, thus contributing to what we have termed ‘reality by extension’ as well as to ‘reality by appearance’” (Teigen and Brun, 124). Indeed, it may be argued that a projected reality draws from a causal chain of mostly inductive understanding. The elements included in the picture may well be influenced by the availability heuristic, prior knowledge, and belief structures. This *causal* approach, as discussed in Chapter 2, provides a link between inference and belief, as was sought by Adams (1995) in his own work on risk and assessment.

### **Decision Making under Ignorance**

The behavioral literature rarely ventures beyond risk and uncertainty based thinking towards ignorance. Those researchers that sail towards these uncharted decision waters bolster their investigations by rooting their studies in conventional probability based definitions of ignorance. These range from an infinite number of probability distributions (Einhorn and Hogarth, 1986) in an a priori distribution of marbles in an urn, to a total lack of information, again on probability and outcome (Hogarth and Kunreuther, 1995). Hogarth and Kunreuther approach ignorance by placing it within the context of the psychological literature of decision making as an extreme category of information. In other words, their definition of ignorance is the same as Knight’s meaning of uncertainty: a lack of probabilistic information.

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<sup>41</sup> Not only does this strike of similarity with Knight’s recommendations, but it also has relevance to the insurer’s options for managing risk (cf. Chapter 1).

Hogarth and Kunreuther designed a decision experiment to ascertain subjects' judgement processes under ignorance in the form of 1) reference points used and 2) arguments taken to justify decisions. Their experimental example was that of purchasing a warranty for a piece of sophisticated electronic equipment. Under the standard choice model, one would compare the price of the warranty with the expected costs of repair. The authors provided the respondents with a pre-designed matrix of decision situations with respect to different degrees of Probabilities and Losses, ranging from Precise / Precise, to Ambiguous / Ambiguous, to Ignorance / Ignorance, with combinations in between. Most decision studies focus on the Precise / Precise case, rendering this example within behavioral decision making as quite innovative.

The investigators asked their subjects to describe the arguments employed (from a list given) and those informational references upon which they relied when the probability of breakdown or the cost of repair expenses was not available. The study focus was thus on how a lack of information on either one or both of these decision parameters affect the decision maker's evaluation of options. The study results comprised a tabulation of arguments used by the subjects, and notably a list of the "weight" of the arguments in their decisions, as determined by each participant, from a list of pre-prepared arguments.

Hogarth and Kunreuther provided a rationale that under conditions of 'risk,' tradeoffs are outlined clearly, while under ignorance, the decision makers must field arguments to support their positions. The main findings of the experiments were that under conditions of "ignorance" in one or both parameters, arguments were much simpler, more one-sided

and justificatory than arguments concerning decisions taken under risk. This finding is similar to Baron's (1988:223) observation that availability of evidence may bias arguments in which one tends to seek evidence in favor of an initial belief, as opposed to evidence against it. Hogarth and Kunreuther noted (1995: 32)

“It is perhaps ironic that, under ignorance, when people should probably think harder when making decisions, they do not. In fact, they may be swayed by the availability of simple arguments that serve to resolve conflicts of choice...”

The data from the Hogarth and Kunreuther experiment suggested two basic forms of argumentation: one, called the metastrategy, used generalised principles to justify decisions, while another, the non-meta strategy took specific features of the decision problem into account in justifying decisions.<sup>42</sup>

By placing ignorance in the context of knowledge of probabilities and outcomes, Kunreuther and Hogarth provided continuity in the decision making literature. A completely epistemological approach in the style of Sahlin's epistemic risk, which structures ignorance as not knowing what one does not know, has no roots in the field of decision making.<sup>43</sup> In their work, Kunreuther and Hogarth render a rather Keynesian analysis of the importance placed by decision makers to certain pieces of information in the creation of different justificatory arguments. One caveat in such research is that participants may be rationalizing their decisions ex post. Another potential problem is the

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<sup>42</sup> It is interesting to note that the subjects were not prompted to request further information, or indeed to allow a questioning of the framework of the decision questions, or entertain skepticism of the decision framework to enter into their response forms. In other words, the respondents accepted all decision criteria of the designers.

<sup>43</sup> As economics demands a determinate outcome, as discussed previously, such a concept of ignorance has only been treated in the sociological literature. Moreover, economics also treats epistemological issues in the logic sense and within game theory frameworks, while conceptual weight of argument approaches might

confusion of ignorance with Knightian uncertainty, which might be the case in this example. Ignorance may be a screen to ask different questions of the decision maker – instead of probability based questions, argument based questions are asked.

The Kunreuther and Hogarth study provided several other interesting proposals. Confirming the gambling analogy as inappropriate due to the lack of context (Einhorn and Hogarth, 1981; Payne et al., 1992), they also suggested “the need to expand the treatment of decision making under risk, ambiguity and ignorance. Thinking of choice as an argument with oneself may help to enrich the standard paradigm.” (Hogarth and Kunreuther, 1995: 34) Such a recommendation leads quite naturally to the concept of “weight of argument” used by Keynes (1921) in a study of argumentation style and structure, and influence on decision outcomes. At the same time, the experiments outlined did not provide any discussion of interpretation of the problem by the participants. The researchers assumed the selection among options as objective, interpretation free choice, and thus adhered to a positivist approach towards decision making.

Although the Kunreuther and Hogarth study focused on participants’ arguments, it would be elucidating to add a few more questions probing the causal framework of the decision maker as to why particular arguments were chosen as well as the influence of external justification to the selection of arguments. After all, the study did consider argumentation as a form to settle the “conflict of choice” (Hogarth and Kunreuther, 1995: 32). Decision psychologist Baron (1994) noted that in judgment, especially under circumstances of

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prove to have greater explanatory value. Kunreuther also mentions that Arrow considers uncertainty to be

incomplete information (such as catastrophic risk) subjects' expression of confidence in their conclusions had much more to do with the proportion of indications in the given evidence (i.e. the probability of the evidence, or its direction) and not nearly as much by the sample size (weight of the evidence, or its credibility). Indeed, subjects were likely in their search for information to take prior beliefs as guides, thereby biasing their investigation towards conclusions they may have already held and discrediting alternative hypotheses. These results also hold in the formation of causal judgments.

It is Baron's view that initial beliefs are very difficult to dislodge, once formed and informed by memory. Baron also cautions that beliefs are not invariant across all contexts and can be contingent on the multiple roles of the decision maker, depending on "whom we must persuade." (Baron, 1994: 300) Moreover, the influence of group-think on individual decision making should not be underestimated (Yates, 1992; Janis, 1982). The individuals' routine decision making contexts will also affect their treatment of recurrent risk decision making situations. "Anyone who is used to taking risks (for example a surgeon or a stock portfolio manager)," Baron remarks, "is probably able to handle feelings of regret...you learn to put your losses behind you and move on." Baron also states, in confirmation of Heath and Tversky (1991), that as self competence increases (i.e. knowledge of a situation involving judgment), the effect of missing information must be viewed differently than as simply perception. Philosopher and social psychologist Rom Harré (1986) acknowledges the complexity of decision research by noting that it is usual among people to confirm the pattern they expect to see, rather than discover other

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inadequately treated in economics (Hogarth and Kunreuther, 1995).

patterns – a form of anchoring and adjustment.

### **Naturalistic Decision Making**

Naturalistic decision studies seek to inform theoretical concepts, such as uncertainty, with context and praxis oriented investigations (Huber, 1997; Lipshitz and Strauss, 1997). This branch of decision studies takes a cue from Simon's emphasis on observing and analyzing actual decision situations, but does not take bounded rationality as a starting point. For example, in their study involving fighter pilot decision making patterns under uncertainty, Lipshitz and Strauss differentiated among types of uncertainty: incomplete information, inadequate understanding, and undifferentiated behavior (thereby enlarging the uncertainty conception of the behavioralists, framed by expected utility theory).

Lipshitz and Strauss found a systematic relationship between different conceptualizations of uncertainty and different methods of coping. When uncertainty was perceived as lack of information, assumption based reasoning was often used. With inadequate understanding, the agents employed reduction tactics such as the collection of additional information. Finally, in the case of undifferentiated alternatives, the subjects weighed pros and cons. Other effects, such as forestalling, were as likely on each of the types of uncertainty. Suppression of the uncertainty was least likely. The significance of the Lipshitz and Strauss work is the emphasis that "decision making begins with an attempt to understand, recognize or make sense of the situation" (Lipshitz and Strauss, 159). Such a conclusion follows in the style of Weick's organizational decision theories (Weick,

1979, 1995) as well as cognitive studies by Klein (1993) and Pennington and Hastie (1993). In conclusion, Lipshitz and Strauss state (1997: 161),

“Decision makers cope with uncertainty adaptively, matching different types of uncertainty with different coping strategies that are suitable to human bounded rationality, resorting to suppression tactics only if all other strategies of coping fail.”

This study points to the importance not only of role in decision making (Baron, 1994; Sen, 1996), but also differentiated uncertainty as constructed in choice situations (i.e. not ready given as in experimental conditions) and the important effects of organizational context.

In the next section, a brief overview of Weick’s research into expectation as sensemaking is given in the context of some key works in the organizational literature on decision making. Organizational context influences the structuration of risk and uncertainty. However, as the thesis focus is individual decision making, the organizational literature is only given a brief overview for reference.

### **Expectation as Sensemaking**

Accounts of organizational behavior follow positivist (Huff, 1990), structuralist (March and Simon, 1993; Cyert and March, 1992; March 1999) and interpretationist perspectives (Weick, 1979; Weick, 1995). This section will highlight Weick’s work, since his use of knowledge and information most closely resembles that of epistemic probability, or Keynes weight of argument. Weick focuses on the stage prior to interpretation that he terms sensemaking. He distinguishes between sensemaking and interpretation in the

following excerpt (Weick, 1995: 13),

“A focus on sensemaking induces a mindset to focus on process, whereas this is less true with interpretation. Even when interpretation is treated as a process, the implied nature of the process is different. The act of interpreting implies that something is there, a text in the world, waiting to be discovered or approximated. Sensemaking, however, is less about discovery than it is about invention.”

According to Weick, sensemaking begins as a pattern of recognizing particular signals while ignoring others in forming choice situations. His studies reveal the plurality of meanings in decision situations, and that decision makers often have too much information, not too little. He remarks that, “the problem faced by the sensemaker is one of equivocality, not one of uncertainty. The problem is confusion, not ignorance.” Such an approach may find affinity in a Keynesian subjective weight of argument approach applied against a causal field. Weick is appreciative of the influence of causal attribution and of memory. In particular, group decision makers may not agree on the storyline of past events, rendering a definition of present circumstances open to contestation.

Weick mentions that the enacted world (Weick, 1995: 37)

*“has its ‘origin’ in mental models of causally connected categories that were part of the strategizing that carved out artifacts in the first place.”* (my emphasis)

Indeed, this thesis has sought to disaggregate the decision making activity of catastrophe underwriters into categories of understanding of praxis. By using such an approach, a nuanced perspective is allowed which does not seek a standard in rationality, but of description and explanation.

Weick does not concur with the behavioralists' choice of emphasis on errors in decision making and rationality. He argues that the criteria of accuracy is secondary to that of sensemaking, due to information overload and the need to filter a coherent set of signals.

Weick concluded from his organizational and empirical perspective that (Weick, 1995)

“...from the standpoint of sensemaking, it is less productive to follow the lead of behavioral decision theorists (e.g. Kahneman, Tversky, Thaler) who gloat over the errors, misperceptions, and irrationalities of humans, and more productive to look at the filters people invoke, why they invoke them, and what those filters include and exclude.”

Organizational theorists Starbuck and Milliken (1988) agree. When people put stimuli into frameworks, this enables them “to comprehend, understand, explain, attribute, extrapolate, and predict.” (Starbuck and Milliken, 1988 : 51)

## **Conclusion**

The decision making literature in economics and psychology is rooted in conceptions of risk and uncertainty based on probability. The decision paradigms are greatly influenced by metaphors of a priori probability distributions, particularly colored marbles in urns.

The treatment of knowledge is lacking in decision making studies, which has mostly do to with the focus on probability, departures from “rationality,” and the assumptions of expected utility theory. This chapter's selection of emerging insights in the decision making literature points to a broadening of this probabilist approach to include causal attribution in judgment and the influence of organizational context. In this way, knowledge in judgment could be incorporated into decision making under uncertainty.

One framework has been proposed in Chapter 2 as Keynes weight 2 of argument in combination with Mackie's causal field.

Taking probability as a component of decision making within a causal field, the conceptions of uncertainty can be differentiated as occurring within decision making *routines* and judgment processes. Naturalistic decision making and organizational studies both take situated uncertainty as their starting point. The value of this approach is that it allows a greater epistemological and organizational structuration of uncertainty. It also leads to a reappraisal of the validity of pre-set decision studies to shed light on the sense making “front end” of decision situations and the routinization of decision situations in praxis.

The next chapter focuses on several different approaches to modeling underwriting practices. The various perspectives highlight judgment and assessment processes in the underwriters’ decisions, as well as formation of expectation within the reinsurance decision environment.

## **CHAPTER 6**

### **Decision Making and Underwriting**

## **Introduction**

As a mixture of art and science, underwriting is difficult to formalize. Many of the routines of decision depend on social practices and market cycles. Decision making under uncertainty meets models of underwriting in this chapter. In the different approaches to formalizing underwriting, such as expected utility theory, portfolio theory, and risk theory, the common underlying theme is the inability to capture the essence of praxis. Other perspectives include underwriting as assessment, but these models neglect the organizational and market contexts.

This chapter will present an overview of these studies. They consist of a survey of actuaries, insurers and reinsurers, an underwriting assessment model, a manual on underwriting, participant observation of catastrophe reinsurance underwriters, and an attempt to elicit “decision rules” from lead underwriters. The diversity of approaches make for interesting comparison; at the same time, the approaches frame the character of the studies: as descriptive or normative.

## **Economic Theories of Decision Making and Underwriting**

Kunreuther et al. (1993, 1995) carried out a series of studies and surveys among actuaries, insurers, and reinsurers to assess to what degree their choices over prospects reflected the axioms of expected utility. The study was performed in three phases, sending questionnaires to actuaries, insurers, and reinsurers. As elaborated in Chapter 5, the expected utility theory of economic decision making assumes an isolated decision maker selecting among risks, or choices expressed as combinations of probabilities and

outcomes. Rational decisions are defined as the selection of those options with the highest expected utility. Kunreuther et al. used a matrix (Table 9) to map out potential insurance pricing scenarios based on a selection of risks expressed as types of probability and loss. The probabilities were either well specified or ambiguous (Ap), while the loss was either known or uncertain (UL). Ambiguous probability referred to a probability range (expressed as views among “experts”) while uncertainty referred to a best estimate, also in a range. The authors asked actuaries, insurers and reinsurers in a postal survey to price these four types of risks.

**Table 9: Matrix for insurance and reinsurance pricing survey**  
(Kunreuther et al., 1993)

<b>PROBABILITY</b>	<b>L O S S</b>	
	Known	Uncertain
Well Specified	p, L Life, Auto	p, UL Playground accidents
Ambiguous	Ap, L Satellite, new products	Ap, UL Earthquake, Underground Storage Tanks

The hypotheses of the study were that insurance managers would be risk averse (i.e. pricing higher than expected utility for a known probability and loss). The authors also surmised that respondents would be ambiguity averse, and use constraints and reference points in making pricing decisions under ambiguous probabilities. In the first (postal) survey of actuaries (Hogarth and Kunreuther, 1989) fifteen “explicitly and spontaneously” indicated that they used the anchoring and adjustment process, i.e. the anchor was expected value and was adjusted if there existed ambiguity in the probability or uncertainty in the loss. The actuaries’ responses also documented the calculation process for two identical loss scenarios of \$100,000 with differing reliability of

probabilities. One involved a certain probability of .35 while the other involved an ambiguous probability of .35. The Wharton team found that actuaries added a “conflation factor” to account for the ambiguity in the risk. Even without the ambiguity, some actuaries added a loading factor to their calculations. The actuaries could thus be considered as risk *and* ambiguity averse.

**Figure 10: Actuaries add loading factor to ambiguous probability**

“100,000 x .35 x 1.25 (Conf factor) = 43,750”      (Ambiguous probability)  
“100,000 x .35 x 1.0” = 35,000      (Certain probability)

In the underwriter survey, findings of aversion to ambiguity in probability and uncertainty in losses were also found. Underwriters responded with minimum pure premiums higher than expected loss even in the absence of uncertainty and ambiguity. For certain probability and loss scenarios, recommended premiums were considerably higher than purely expected value by an average of 63%! In the cases of earthquake vs. the neutral peril, one of the normalizing tests for the survey respondents, underwriters priced higher for an uncertain loss than for a corresponding ambiguous probability in the earthquake case but reversed their pricing decisions for the neutral peril case. For the underground storage tank, pricing was higher with respect to ambiguous probability than for an unknown loss. Underwriters would add significantly to the price when the risk was characterized by both ambiguous probability and uncertain loss. The Kunreuther matrix promotes the traditional marbles-in-urns view of probability, uncertainty and ambiguity, while at the same time seeks to test how neoclassical economics fails in this case.

Some of the questionnaire data was supplemented by interviews, partly to offset a low response rate among insurance underwriters. Interview data revealed that underwriters were reluctant to accept low priced, low probability business due to its narrow profit margin. Moreover, several insurers' reinsurance treaties required a minimum premium for catastrophic risk, regardless of the amount of insurance coverage offered. The study also found that underwriters at mutual companies offered lower prices than those from stock companies for the same type of coverage. The size of the company was not found to be a significant factor.

Kunreuther et al.(1995) thus found empirical evidence of expected utility theory being contravened. The team offered several explanations for ambiguity aversion among primary insurance underwriters. One explanation referred to the external scrutiny and responsibility of underwriters' decisions. Curly, Yates, and Abrams (1986) found greater ambiguity aversion in those who were aware that their decisions would be monitored by others. Another explanation was informed by the work of Heath and Tversky (1991), that subjects were averse to betting when they felt own competence was lacking.

Other explanations by the Kunreuther study as to why underwriters price ambiguous risks more highly was avoidance of the "winner's curse," (Thaler, 1992) i.e. winning the business through lower premiums but having an expected loss. The costs involved with collecting information on low probability risks could also contribute to the higher premium charged. Finally, the study noted that the particular risk context (i.e. whether it

is earthquake, underground storage tank, or nuclear peril) also affects the nature of the ambiguity, as differentiated price increases were observed.

However, while this consideration of tacit familiarity with the topic is important to the feeling of competence, the literature does not consider the possible outcomes *if no decision is taken at all* as in the case of the underwriter. It is important to keep in mind that the state of the market at the time of the decision influences the perceived decision alternatives. There is also the consideration of personality and the degree to which the underwriter is risk seeking or risk averse in particular situations. The information given has to “make sense” to the subject within a known knowledge framework – this could be previous experience with the situation in question, analogies from one situation to accommodate similar features of another, and personal familiarity – which is also affected by perception and the effects of role and responsibility (Kunreuther and Hogarth, 1985). Other biases included maintenance of predisposed beliefs regardless of new evidence to the contrary (Baron 1988).<sup>44</sup>

Recall Ellsberg’s (1961) consideration of ambiguity concerning probabilities also referred to the nature of “one’s uncertainty or lack of knowledge about particular uncertain events.” Along this line, one could argue that according to familiarity with the risks under contract, underwriters would be less willing to take a chance in an area for which the risks are relatively new and few (such as a new satellite) than for ones where

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<sup>44</sup> This thesis argues that the evidence is sought depends on the causal framework and the knowledge framework (or epistemology) of the individual’s task environment. The interpretation of that knowledge and its *use* depends not only on the above mentioned factors but also on organizational practices.

the risks are familiar and plentiful (housing protection against earthquake). An important consideration is the underwriters' estimate of the effect of losses on other insurers offering coverage for similar risks. For natural perils, the risk affects all underwriting in a particular area, and therefore, the underwriter might consider that if losses occur, they would affect competitors just as severely (unless there is great differentiation in the purchase of reinsurances). The priority for some underwriters may therefore be market share and justification of premium to capital on shareholders' balance sheets.

This situation could be turned on its head in the case of underground storage tanks liability insurance, which could be seriously damaging for one particular insurer. The Kunreuther team also did not investigate in detail how this pricing decision is affected by the retention on that risk; i.e. what part of the risk can be transferred to the reinsurance markets either through facultative, quota share and excess of loss contracts. In other words, it is difficult to reduce the causal alternatives. Market relations and the role of brokers are also not treated in the Kunreuther et al. framework.

The Kunreuther study went on to suggest that primary insurance underwriters are usually less analytic and more likely than actuaries to be comfortable with ambiguous risks since they are the front lines in the risk market. They also state that underwriters are unlikely to use probabilities in their thinking, making judgments based on more qualitative information such as the care of the client in managing risk. Therefore, a weight of argument perspective with regard to underwriters' decision making may be a more fruitful approach than expected utility or profit maximization.

A final survey was sent out to *reinsurers*, requesting similar pricing information. However, only 9% of reinsurers returned their survey forms. This poor response rate prompted more informational interviews, which found reinsurers setting premiums on the basis of simple rules and heuristics focusing on potential *losses*. Indeed, March and Shapira (1987) found in organizational decision practice, reference points not related to the risk in question become particularly important when information on the risk is ambiguous or poorly specified. One particular reference point for reinsurance underwriters was the premium to surplus ratio,  $R$ , which for American regulatory and rating purposes assumes a very important role. Another reference point is that of the risk of ruin, or the probability  $p^*$  representing the maximum probability of insolvency the firm will tolerate. The fact that reinsurers focus on losses, not probabilities, could also have to do with their own reinsurance / retrocession decisions.

The reinsurers appeared to be both ambiguity and risk averse. The interviews also found that reinsurers' choices depended on the origin of ambiguity, much as Ellsberg stated. These important considerations from the Wharton study in the epistemology and psychology of underwriting judgment presented a curious paradox. If a risk was unfamiliar or expertise could not provide a clear assessment, the risk was likely to be accepted with a loading factor in the price. On the other hand, if within a known knowledge of the risk, information was missing or not credible, then the underwriter would refuse coverage. It could be said that the weight of argument in the second case does not provide a probability tending to favor the risk, while in the first case the weight

of argument does not sufficient deny favorability of the risk. Knight's uncertainty could be modified to be that condition of knowing what one does not know, while ignorance is not knowing what one does not know. Hedging against what one does not know might have been considered easier than accepting a risk for which one knows particular important information is missing.

On the other hand, the paradox could be solved if one considers that a primary responsibility of the underwriter is to garner premium income and to justify losses. If losses occur on policies for which important information was not provided, it may be more difficult to justify such decisions than for policies on unfamiliar risks or those for which even expert opinions are divided. The Wharton studies did not investigate in detail the organizational factors in the underwriting decisions, such as relations with brokers, firm level strategies, or market conditions which may have elucidated the reasons for the risk propositions being accepted or rejected. However, the study did note that an important source of ambiguity concerned the credibility of the *primary* underwriter, thus hinting at the importance of trust and business relations, especially in the face of missing information or uncertainty.

Kunreuther et. al. concluded that the predictions offered by expected profit maximization and expected utility do not characterize underwriters and actuaries. Such important factors included the type of risk being insured (not simply their comparability as to total expected value) and the context of underwriting. They recommended "the systematic exploration of context effects in future research" (Kunreuther et al., 1995: 348) echoing

an earlier study by Kunreuther and Schoemaker (1982) advising greater descriptive research in decision studies. This thesis in effect answers this call for “thick description” through stylized decision facts.

### **The Classification Method**

Another approach to insurance underwriting models has been to chart a descriptive account of assessment in evaluating and pricing risks. Operations researchers Lawrence Phillips and Thomas Wisniewski investigated underwriting practices in Britain in order to build a Bayesian underwriting decision framework. They provided the following glimpse of the decision making tools in use at the time in the journal *The Statistician* (Phillips and Wisniewski, 1983).

“Statisticians who are unacquainted with insurance underwriting are usually surprised to discover that premia are determined for most classes of business without regard for statistical databases, statistical models, or, indeed, any modern statistical methods. A recent survey in Great Britain revealed that many insurance companies do not employ any statisticians, that few employ more than one or two statisticians, and that methods for determining rates rarely extend to techniques as sophisticated as linear regression, with no hint of multivariate models being used. It comes as a further surprise to look at rating manuals which give the actual procedures used by underwriters; there is never any mention of probability. Most underwriters are unacquainted with the basic laws of probability, let alone the simplest distinction in statistics such as the difference between mean, median and mode. And yet, until recent times, underwriting has consistently made a profit, so the procedures used must have some validity.”

The authors go on to describe the “average line” approach which characterized most primary insurance underwriting procedures. They note that it makes no reference to probability. The procedure is summarized below in Figure 11. It is interesting to probe the meaning of the authors’ last phrase, in that the decision routine “brought about profits” and therefore held some “validity.”

**Figure 11: “Average line” method of underwriting** (Phillips and Wisniewski, 1983)

Presented Risk → Classify (Base Rate) → Assess (Pure Rate) → Add X% (Commercial Rate) → Adjust (Quoted Rate)

The presented risk is first classified in a set with a pre-established base rate, which is average or normal for the class. According to the authors, the base rate is usually determined empirically depending on rates of the previous year, the market's competitive conditions, and claims experience over time. The risk is assessed taking note of desirable/undesirable features with concomitant loadings or deductibles. These adjustments are advised by "the collective judgments of experienced underwriters" and not heavily reliant on statistical features.

Judgment plays an important role in assessing the weight of unusual claims experience on the risk class, the relevance of historical data to the future, and the impact of new technologies on the degree of risk. This price, the pure rate, is intended to represent the particular risk and its features, against the backdrop of the risk class and the management's risk attitudes. Profit, commission and expenses are loaded in the commercial rate. It is important to keep in mind that market conditions could impel the underwriter to increase or decrease the risk premium. Moreover, the process is not uniform among underwriters, and the same risk could very well receive different quotations, even within the same company.

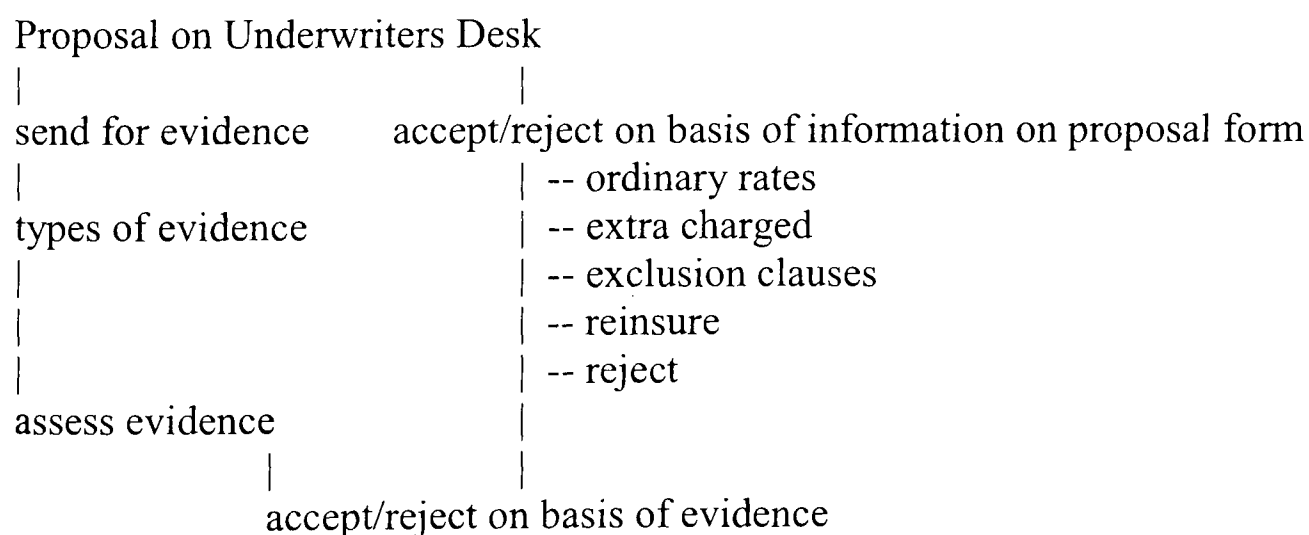
Although presenting an empirically informed practitioners' perspective, Phillips and Wisniewski provide little organizational input in the decision making process, nor much discussion of the type and quality of evidence employed to assess risks, and if criteria

other than frequency or subjective probability are being used. However, Phillips and Wisniewski's investigation revealed the routinization of decision making based on past decisions and databases of past classifications. This routine of assessment does not take into account changes in the classification system itself, and could fall to catastrophic surprise if the nature of the risks changed significantly.

### Decision Rules and Tacit Knowledge

Another perspective to the underwriting process is to distill the underwriter's *assessment* rules. Bolger et al. (1989) followed this approach in developing an underwriting model for *life* assurance. It contained as its core a chart idealizing the decision process of the underwriter, presented in Figure 12 below.

**Figure 12: Underwriter's evaluation procedure** (Bolger et al., 1989)



Bolger et al. developed the underwriting training computer model through knowledge elicitation techniques of senior underwriters in order to capture as many rules in as many

different contingencies as possible.<sup>45</sup> They organized these rules within 6 modules corresponding to types of evidence. As an example of the sheer number of decision references, one module contained 150 “expertise” rules to sift through medical reports. The knowledge elicited was represented in the form of a decision tree.

The authors intended to use their decision support tool for health assurance to inculcate junior underwriters in recognizing salient material. They therefore asked chief underwriters how the learning processes occurred in the market. One-to-one conversations between more experienced underwriters and their juniors were cited as the main route of learning, and such conversations occurred generally *when difficulties arose*. In other words, usually in the case of a conundrum or an ambiguity, the junior underwriter would seek consultation with the senior underwriter. This behavior seems to confirm Weick’s thesis that sensemaking occurs at a number of levels and is also manifested by interruption in the sense making scheme (Weick, 1995). It also supports Weick’s affirmation that more studies should be devoted to descriptive accounts of judgment and less on departures from a standard of rationality.

The authors conducted extensive interviews with insurance underwriting practitioners, requesting an explicit mention of just that tacit knowledge differentiating an experienced underwriter from a novice. What is the combination of experience and intuition that could inform their decision model and provide the raw material for their “decision rules?” Below are two responses from senior underwriters.

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<sup>45</sup> The knowledge elicitation techniques included structured and unstructured interviews, card sorts,

“A good underwriter will home in on the two key words in the medical report...a junior underwriter wouldn’t.”

“The chances of missing a salient point in a report are minimal but I’ll find it in a few minutes whereas a junior underwriter will take a lot longer.”

The responses are especially interesting in their emphasis on the recognition of relevant knowledge from reams of information (much like in the case Weick presupposed). In other words, the leaders were aware of the significant clues to spot, and did so within a causal framework informed by their risk experience, routines of assessment and participation in the risk market. Such a procedure, assessment by route of the weighing of relevant evidence, takes directly from Keynes’ weight 2 and Mackie’s causal field. Such information selection is dependent on the underwriters’ assumption that the conditions of underwriting itself (in any of the points of reference used in a causal framework) in a particular market have not changed. Evidence based reasoning, contributing to an overall “feel for the risk” and the recognition of relevant omissions or inconsistencies in risk information are the trademarks of the experienced underwriter.

### **Participant Observation and Catastrophe Reinsurance Underwriting**

In contrast to the work of Bolger, which investigated mostly the life assurance context, Ayling (1982) focused on *catastrophe reinsurance*. His methodology consisted of participant observation in an English reinsurance company from 1976-1980. The main reinsurance business was *aviation excess of loss* contracts, but the challenge of low probability, high consequence coverage remained the same, comparable to coverage for

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repertory grids, and context focusing.

natural perils. Ayling's study rests on the premise from a reinsurance manager stating "You will never replace a catastrophe underwriter with an equation." (Ayling, 1982)

Ayling's research involved a review of the theoretical risk literature in economics and finance. His finding was similar to that of Phillips and Wisniewski, in that risk theory was shown to be practically ignored in reinsurance practice. One reason was due to the inherent uncertainty in the underlying risk. Such fundamental uncertainty vitiates the application of Markowitz' portfolio theory. Therefore, purely "rational" pricing methods are theoretically very problematic for the reinsurer. As mentioned previously, the "law of large numbers" is also difficult to apply, since the risks are not homogeneous, easily measurable, or amenable to a "representative" sample. As a result, decisions are often made on incomplete information as compared to what risk or finance theory would require.

Of the behavioral decision literature, Ayling (1982) advocated Simon's concepts of bounded rationality and satisficing. In his work, he recommended an interdisciplinary approach to studying underwriting, combining areas of behavioral decision theory and management science in "trying to understand [the practitioner's] frame of reference" (1982: 80).<sup>46</sup> He also supported a greater framework of analysis, such as one offering a causal perspective in an ethnographic sense. Such a commentary on future research finds a response in the present thesis.

In the course of explaining the reference points of reinsurance underwriters facing uncertainty, Ayling compared the reinsurers' predicament with an analogy of the management of recurring floods in the Nile basin in ancient Egypt. The inhabitants of the river basin did not understand the causality of the flood occurrence, but they did perceive a correlation between the sighting of the god/star Sirius on the horizon the dawn of the flooding event. Therefore, they construed for themselves through religious custom a causal framework for the event. "Since the Nile's flood itself could not be predicted, attention turned to a more measurable phenomenon: namely the path of Sirius, which could be monitored in a more predictable fashion," Ayling stated (1984: 78).

Both the Egyptians and reinsurance underwriters relied on *heuristics* to enable them to carry out their daily decisions. Not only did the heuristics simplify and prioritize the number of causal cues, these heuristics also enabled both groups to maintain the coherence and consistency of their world view. According to Ayling, the businessman is less interested in understanding the way the heuristics work than in their empirical success. In other words, the heuristics allowed an accommodation to effects without readily identifiable causes. This particular analogy also harkens to the finding by Kunreuther et al. that reinsurance underwriters use reference points in their decision making routines.

Ayling's subsequent investigation of underwriters decision processes sought to determine which pieces of information on the slip held greater weight. The core details of the slip

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<sup>46</sup> Although he remarked that behavioral approaches have been applied to insurance contexts, very few have

include the premium income of the company being reinsured, the upper and lower limits of the policy, and the signature of a lead underwriter on the business. Ayling found significant correlation between the market price of the excess of loss contract (i.e. the decision outcome) with the *premium income* of the company being reinsured. The reinsurer's portfolio selection was also strongly correlated to the premium income of the company. Surprisingly, decision outcomes did not appear correlated with the underlying risk processes, and portfolio selection was taken neither on underlying risk processes nor on contract details.<sup>47</sup>

Ayling found that the larger the premium income of the client, the greater the reinsurance premium charged. Another correlation was found between the layer of reinsurance under contract and the premium charged, the uppermost layers being charged less than those "burning" layers so named due to the higher chance of loss. However, it was not only the slip details, but also the firm's and underwriter's position in the market that came into play. The underwriter tried to select those contracts with higher than average market rates and accept less business at lower than average rates. This strategy maintained high income relative to other firms or syndicates. Hence the underwriter priced either on the basis of risk and return of the slip details, or priced above market average on contracts, using slip details to establish the relative desirability of various contracts (i.e. using slips as a comparative device). Ayling stressed the importance of market conditions in pricing, and added that brokers were able to put pressure on underwriters to sign a particular

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treated insurance underwriting and almost none have investigated catastrophe excess of loss reinsurance.  
<sup>47</sup> It is important to take into account the context of risk sharing in the reinsurance sector in Britain at the time; underwriters would usually sign a percentage of the layer of the risk being offered.

percentage as premium. This consideration points to power relations within the market affecting pricing decisions. Other influences included market indicators, organizational and commercial arrangements for dealing with problems of uncertainty, and local business practices.

Ayling noted that in practice, underwriters make a “guesstimate” of the appropriate rate with subsequent revision in light of information and the yearly renewal. Several of the heuristics he observed are below in Figure 13.

**Figure 13: Catastrophe excess of loss underwriting heuristics**

- a) Write small amounts of a large number of risks to allow the law of large numbers to apply in relation to loss incidence.
- b) Try for a certain permanence of risks upon the books. This allows for alterations over time to premiums charged to ceding companies on the basis of new information on loss experience.
- c) Include as wide a variety of risks (by class of business and geographically) as possible to lessen the likelihood of a sudden drain on reserves brought about by a single catastrophic event
- d) Charge as much as you can without losing the business
- e) Follow the market crowd or lead underwriter in pricing a particular risk or group of risks

In most of these cases, the uncertainty of catastrophes is treated in Knight’s sense, as an inestimable risk or chance. Indeed, the heuristics follow Knight’s recommendations of a diffusion of consequences through the acceptance of tranches of the particular uncertainty, and accepting a diverse number of contracts in order to decrease the exposure in the portfolio to any one uncertainty. Therefore, Knight’s portfolio of unique cases is in fact employed in the context of risk sharing arrangements in insurance.

Learning over a number of contracts increases the inductive experience with the risk, and

moreover creates a slightly better basis to inform the reinsurer of the insurer's risk management record. The diffusion of consequences can also be evaluated in charging as much as possible in order to hedge ambiguity. Thus, through the number and geographic diversity of risk tranches, the catastrophic becomes routine.

The last heuristic involves following the lead underwriter, thereby transferring the burden of judgement on the credibility of another decision maker. This decision is most clearly shaped by inductive reasoning of the lead underwriter's past performance or reputation and by the causal framework that the market will reward those who follow the lead underwriter's judgements.

Ayling concluded that custom dictated underwriting and that the reason particular procedures were followed (such as pricing based on premium income) could be traced to their reasonableness in providing business results in the past. He did not try to defend the "rationality" of such adherence, stating that "There may, in fact be no rational justification for the procedure other than that it is a convenient way to make business acceptances." This observation would point to greater research being placed on descriptive accounts of routines and organizational influences in decision environments.

Ayling's results are mirrored in the current study. However, while he organized his thesis on the applicability of risk theory to underwriting under catastrophe risk, he did not focus on individual and organizational accounts of behavior under uncertainty. Attention to market forces and the underwriter's reasoning was not addressed in his study.

## **Holtom and the Underwriter's Manual**

The job of the underwriter is to evaluate information, form judgments, and make decisions based on a range of factual and subjective factors. Insurance manager Robert Holtom, in his manual for primary insurance underwriters, places closer attention to the information appraisal process than expectation of loss issues (Holtom, 1987). Comparing the thought process of a deliberative philosopher to the assessments undertaken in the business environment, Holtom remarked that “the least desirable course for an underwriter to take is one of inaction. Inaction and indecision have no place in the underwriting process.” (Holtom, 1987: 94)

Holtom's work stressed the temporal and financial constraints of underwriters' assessment, for example on the amount of information that can be requested and the need for a decision. According to Holtom, the underwriter has a number of tasks, including the selection of risks, application of rates, determination of contract provisions, and cooperation with other departments. In anticipating the worthiness of a new risk to the portfolio, the underwriter relies on an assessment of past performance of the risk. The factors important in the information search are cost, trouble, relevancy and time (not only time to make a decision, but also the time period allowed before the contract becomes legally non cancellable). Holtom, while advising instructional feedback on underwriting decisions, regarded “correction” as applicable towards the *reasoning* of the underwriter than towards the particular risk contract under review. He strongly admonished that “wise management will give considerable autonomy to underwriters” since underwriting

*results* are the main standard of evaluation, not the details of each underwriting negotiation.

Underwriters are not the only branch of the insurance company that must justify their operations - actuarial teams, sales departments, and claims services are also behooved to display their worth to the firm. Therefore, it is not uncommon for conflict to occur, i.e. for a sales team to support more contract acceptances, while the actuary signals restraint and the underwriters remain committed to independence in the decision making procedure. The claims department is responsible for carrying out investigations when losses occur – which could reflect unflatteringly on the underwriter who wrote the contracts. Underwriters are also called by claims personnel for interpretation of contracts, especially on questionable submissions.

Holtom regarded prudent underwriting as a balance between risk opportunity and risk danger. If the risk dangers increase (due to greater coverage offered, lower prices, or less careful underwriting) then risk acceptance must be tightened in order to protect the company. In other words, investigating risks became even more important if the liability to the company becomes greater. Holtom further maintained that “when accountability and responsibility are removed from the underwriting department, an insurance company has taken a long step toward financial ruin.” (Holtom, 1987: 50) In an important consideration evoking Tversky and Heath’s (1991) decision experiments, he noted that if underwriters faced unfamiliar risks (or did not feel competent to make decisions on certain risks), morale tended to decline. Holtom recommended the following procedure

certain risks), morale tended to decline. Holtom recommended the following procedure for underwriting assessments, shown in Figure 14. The process resembles a combination of assessment with an evaluation feedback loop for learning purposes. The difficulty in applying this procedure to catastrophe contracts, as opposed to primary insurance contracts, is the limited feedback on contracts due to the scarcity of catastrophe occurrences, as detailed in Ayling's findings.

**Figure 14: Decision making in underwriting (Holtom, 1987)**

application → secure information → develop alternatives → decide and take action → check results → evaluate action → make corrections

The market context of underwriting plays a larger role than that explored in the underwriting models discussed. Holtom recalled the insurance market during the mid 20<sup>th</sup> century in which underwriting business cycles were regular and rather predictable. He remarks that an expectation of 3 years profit followed by 3 years of losses, was a general norm between 1940 and 1980. The relative stability in the market ended in 1979, with a period of losses lasting until 1985, an “unprecedented depression.”

The long down cycle had also caused numerous losses among reinsurers, with even a poorer result than in the primary insurance markets, which was highly unusual. In fact, of the 130 companies that sold reinsurance in the United States, about 100 left the business, thus decreasing the capacity of the market at that time, and restricting the avenues of reinsurance protection. Due to the time lag between underwriting and financial results, management of firms usually experienced a delay between knowledge of a profitable period and the actual start of the upswing. At the same time, Holtom noted that managers

were vexed that underwriters trained during the down cycle of over-capacity and cut rate pricing “never learned how to underwrite [i.e. assess risks] - they had learned only how to reduce rates below those of their competitors.”

## **Conclusion**

As the works treated in this chapter indicate, most academic studies of insurance underwriting neglect the risk market. Instead the focus has been on the individual underwriter’s assessment tools or probabilistic decision matrix. Moreover, the critical role of relationships among underwriters, brokers and clients are usually left untreated, except for general discussion of moral hazard. The focus on utility or maximizing decision factors could be due to the direct application of the traditional economic urns paradigm to insurance context. While most of the perspectives on underwriting in the face of catastrophe risk have been economic, it might be elucidating to apply epistemological, psychological and organizational considerations to decision making within a particular socio-economic milieu.

In addition, the role of probability in insurance studies has been limited to frequency or subjective probability. The discussion in this thesis on probability not only as degree of frequency, but also as weight of argument enriches this original framework. The weight of argument perspective opens the epistemic and organizational environment of underwriting, enabling a study of how ambiguous risks are structured and “managed” in a very local context of information flows, market pressures, and relationship obligations. In the next chapter, the empirical study of the London market is presented in the form of

categories of catastrophe risk underwriting, highlighting the importance of causal cues and relationships in the risk market to mediate decision outcomes.

## **CHAPTER 7**

### **The Categories of Catastrophe Risk Underwriting**

## Introduction

So far in the thesis, the nature of risk, uncertainty and causality have been broached with respect to the risk philosophy and decision making literature. The nature of catastrophes and its treatment in the hazard geography literature have also been addressed. Finally, an overview of catastrophe reinsurance underwriting in the City of London and the rapid changes taking place have been discussed. In this chapter, the empirical material of the investigation among catastrophe reinsurance underwriters and others, described in the introduction, is organized into categories of decision making. The approach to sift the empirical and the contextual into categories has been employed in the economic geography and the critical realist literatures (Yeong, 1997; Bhaskar et al., 1998), and may mirror the decision maker's own compartmentalisations (Berlin, 1978).

When combined with the causal framework of the decision maker, these categories may suggest stylized *decision* facts, a slight modification of Clark's (1998b) stylized facts. These stylized decision facts form a point of departure for the characterization of decision making in a particular context. One of the more interesting features of such stylized decision facts is that they can illuminate routines of thinking that, in changing circumstances, may impede the recognition of change and acceptance of change in an organization.

The four categories of catastrophe risk comprise the evaluation of the peril(s) being reinsured, the vulnerability of the properties under review, the risk market, and the risk contract. In most studies of catastrophe risk and insurance, the first two are treated in

great detail. However, through the empirical investigation, the risk market and the risk contract revealed their dominant roles for the decision maker. In the praxis of risk decision making, the categories are both realist and hermeneutic. Such a combination is not surprising, as risk itself is a combination of “objective” data, perception, and belief. At the same time the peril and vulnerability categories hold a different character than the risk market and risk contract categories.

“Peril” and “vulnerability” are generally viewed by reinsurers in a realist sense as verifiable and objectively discernable to the extent of the present understanding of weather systems, construction materials, and engineering principles. Indeed, these two categories form the basis for catastrophe models. The risk market and the risk contract, on the other hand, are shaped through contingency, organizational and cultural practices, relationships, and causal understandings (*verstehen*) of the marketplace as a medium and as a traditional institution. Indeed, in organizational studies of firm behavior (Weick, 1995; Huff, 1990), causal perception serves as an anchor for the framing of decisions and the routines of assessment. This overview of the empirical analysis provides a description of both the objectified peril and the medium of trade - of sensemaking and the interpretive criteria that structure the weight of argument in negotiations with the broker and the causal field of the decision context.

## **Peril**

Two underwriting concepts in the reinsurance market place the peril in a time space context and are essential to the underwriter’s ability to compare among risks. These are

the *return period* and the *payback period*. The return period is frequently referred to as an idealized number of years between perils of similar magnitudes to occur in a particular region. For example, underwriters may refer to an earthquake risk in Southern California as having a return period of 100 years. The return period assumes basis in frequency data taken over a number of years, and therefore depends critically on the number and quality of recorded data. The “probability” of the peril in the rough-and-ready reinsurance decision routine is simply the inverse of the return period, or 1/100 in any given year for the example given.

Several problems pose themselves with this kind of referencing. Firstly, it is important to ascertain the data sets on which the return period is based – how extensive they are in terms of reliability, spatial accuracy, and number of years of historical evidence.

Moreover, frequency probability may be misconstrued to be the probability of an event in a particular year – such a probability can only be taken in the context of its data set over the period of time for which it was sampled. Another concern is that such data may not differentiate particular climate decadal trends (if noticeable) that could increase or decrease the likelihood of a peril (for example, Atlantic hurricanes and the El Niño phenomenon). Most significantly, return periods may engender false expectations of the future as a mirror of the past.

Based on these points of data accuracy in space and time, applicability to *particular* years, and neglect of inter annual climate conditions, it seems that the return period faces a tough jury. However, it is a standard in the market as a ready reference of the riskiness

of a particular contract to compare with other risks. Based on this use, it is likely that the return period as used by underwriters is a combination of frequency probability and degree of belief probability.

Another term commonly used term to refer to the peril is the *payback period* of a risk, or the number of years required for current premium to pay back anticipated losses arising from a peril affecting the risk. Payback is often used to refer to future expectations to recoup present losses. The following quote from a London market reinsurance underwriter illustrates the payback concept.

“We were told windstorm ’87 was a once in 300 years occurrence. But we didn’t have to wait 598 years - we got another in 1990. What commercial organisation can afford to take a 300 year view on payback periods?”

The inconsistency with the reasoning of this quote concerns the changing value of premium income over time and through different market cycles. No guarantee exists that the premium will remain stable, or the client will remain loyal over the payback period. Indeed, the price for catastrophe reinsurance has dropped by about 30% per year in the last 6 years in a very competitive and relatively long lasting market downturn. Such price volatility does not support the assumptions behind “payback.” Yet this conception is very much in use, especially by brokers in negotiations with underwriters.

The categorization of perils into return periods and payback periods emphasizes the industry practice of extrapolating from past experience to guide expectations of the future. In year to year differences in event patterns, *causal* factors of the peril (as

opposed to purely inductive references), measured more continuously by scientists, could lead to enhanced predictions of catastrophic perils in a *particular year*. For this reason, a more meaningful forecasting method would combine inductive and causal reasoning of factors concerning a particular context of human and physical geography, or a particular exposure.

For many reinsurers, it was the catastrophes of the past few years that prompted a reevaluation of their decision making routines. One of the reasons Hurricane Andrew was such a surprise to the industry is the aforementioned use of past statistics of claims in a particular area to frame future expectations, an inductive approach to forecasting which ignores changing exposure to perils. Many primary insurance companies did not keep track of the increased vulnerability to losses and indeed the number of properties taken under policies, i.e. they did not “monitor their total aggregates.” Moreover, those in the industry simply did not think of scenarios of loss *on that scale* (McDonald, 1999; Meszaros, 1997).<sup>48</sup> Indeed, the standard catastrophe definition for insurers has changed from a loss of a few million in the late 1980s to \$25 million presently (Insurance Information Institute, 1999). American insurance industry representative Lee Bailey remarked, “The first major lesson learned is we have to redraw the parameters of what constitutes a catastrophe.” (McDonald, 1999) Part of that understanding concerns vulnerability.

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<sup>48</sup> The last analogy of an insurance peril catastrophe had been Hurricane Betsy in 1965, affecting a much less sparsely populated Florida than today.

## Vulnerability

In insurance terms, vulnerability refers to the susceptibility of the property to insured loss. Such susceptibility is expressed as the PML, or probable maximum loss.<sup>49</sup> It is another area of fact and judgment for the underwriter. The PML is the centerpiece of many a broker - underwriter exchange, in which the reinsurance underwriter must remain guarded when presented with estimates from the client or the broker, and for good reason. An inaccurate PML is the Achilles heel of the assessment of liability and expectation of future losses. In the catastrophe reinsurance market, the PML of a particular layer of reinsurance is usually either 0 or 100%, since the levels of liability being reinsured are generally high enough to have only the severest storms move through them.<sup>50</sup> The combination of peril and vulnerability of all properties in a particular region is often termed *exposure*. It is a measure of the exposure which catastrophe modeling companies aim to provide.

As discussed, the first two categories of catastrophic risk underwriting, peril occurrence and the vulnerability of the insured properties, can be expressed as a combination of the return period and the PML. They are realist categories, and the uncertainty expressed reflects missing information, accuracy of relevant methodologies or the reliability of the information given. Advances in scientific understanding of meteorological phenomena and climate aid in the forecasting of future trends; however, to predict the track and timing of particular perils remains out of reach, perhaps due to limits of predictability in

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<sup>49</sup> Other terms include the estimated maximum loss (EML) and the possible maximum loss (PML).

<sup>50</sup> The insurance client, however, relies on the PML to define retention levels and needs for reinsurance, as described in Chapter 5.

natural systems. There is a degree of environmental uncertainty that includes not knowing what other factors may be involved in the nature of the climate – the epistemic risk of Nils-Eric Sahlin.

The latter two categories to be explored below, the risk market and the risk contract, are more interpretive. They are based on participation in and interpretation of social practices and conventions. They mediate through reputation and relationships, embedded in an organizational and cultural milieu. The London risk market provides an excellent example of the tacit knowledge of reinsurance.

### **The Risk Market**

The risk market is the medium of trade. Permeated with a singular reinsurance lexicon as briefly outlined in earlier chapters, the market is subject to great differentiation due to the diversity of the syndicates in operation. Competition is rife, and risk information arrives at a cost, as elaborated earlier. This section of the chapter will outline several main features of the risk market, including relationships, mediation through brokers, capital capacity and market cycles. It will present the driving forces of catastrophe decision making in reinsurance.

The London market has historically followed a subscription approach in which a number of separate syndicates sign onto one risk placement. This tradition informs a particular market mentality to follow a lead underwriter. At the same time, the market for catastrophe reinsurance protection is one of the most competitive in reinsurance. One

London market reinsurance underwriter of cat XL declared in an interview “All we ever did was react.” Another reinsurance underwriter at Lloyd’s commented wryly “We follow the market up, down and sideways; we are its captive.” In contrast to these remarks is the more stable context of relationships, social practices, and organizational culture to which each catastrophe underwriter, and broker for that matter, becomes exposed while participating in the London market.

### *Relationships*

The London reinsurance market is formally structured around Lloyd’s and the company market. Lloyd’s however dominates the London market. For a long period, the institution and expertise of Lloyd’s were held almost in reverence among Company Market reinsurance underwriters. One measure of this weighted influence is the share of London market reinsurance contracts led by a Lloyd’s underwriter. Although Lloyd’s covers about ½ of the market risk business by volume, it *leads* about 2/3.

The Lloyd’s leading underwriters are usually established figures in Lloyd’s syndicates, having developed their reputation in particular lines of business. Brokers reinforce the credibility of the leader by approaching lead underwriters to set the terms and conditions on contracts for other underwriters to follow. Many of the following underwriters are much less able to choose their conditions for participation on the slip, and feel obliged through social practices and recurring business from the broker to sign a line of the risk. Other underwriters take the lead underwriter’s authority on the slip as a chance to take in premium for the syndicate without actually assessing the risks involved themselves.

Therefore, there are a variety of conditions leading to participation, some prompting more assessment than others.

The authority and status of market leaders are revealed less by formal scientific expertise or credentials, and more by their reputations, relationships and tacit knowledge of successfully maneuvering the risk market. Some of these leading underwriters are no less than gurus in their profession, and their signature on a broker's slip lends it immediate credibility, such as a rating system would do. Indeed the leader system in London, although on the wane as corporate capital and mergers continue, persists in providing reference for market trustworthiness. The leader system also reveals the extent to which herd behavior is an important factor in market movements.<sup>51</sup> While providing for clear leadership on particular risk issues, the leader system and its accompanying social practices also have drawbacks. When underwriters not competent in a particular line of business set themselves up as leaders on a slip, the market routine to follow could lead to dreadful loss experience. One Lloyd's broker mentioned recently, "There are not enough competent leaders in the marketplace to base catastrophe risk pricing terms. But more people are setting themselves up as leaders." Such misfortune can occur in many lines of reinsurance, not simply catastrophe excess of loss (Challis, 1999).

The assessments taking place in the London market concern not only the risk itself but also the social consequences of participating or declining a particular slip – especially as concerns the leader, the trustworthiness of the broker and by extension, the client. It is

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<sup>51</sup> One example of this safety in numbers mentality was the excess of loss spiral outlined in Chapter 4.

moral hazard and adverse selection at play in the reinsurance market place, since the risk information mediates through several underwriting levels and could indeed become quite sparse at the higher retrocessional levels. Given this lack of information, the “social learning” among new underwriters to the risk market concerns as much with *whom* to continue business as *which* contracts to consider. Therefore, personal evaluation of long term relationships with brokers and clients forms a particularly important touchstone for risk evaluation. The late Robert Kiln cautioned new underwriters about the risk market and the formation of relationships, commenting (1989: 26),

“Never forget that reinsurance is not a friendly pool of nice friendly fish. It is an unfriendly sea full of sharks and piranhas and Portuguese Men of War and a few other nationalities too! Some people may like you, others may trust you and want you to see and underwrite their good business. Before ever setting pen to paper ask yourself ‘*why me?*’ Why is this person asking me to underwrite this piece of business. And if you do not know the answer or if the answer is flattering to you, stop, think and reconsider.”

Kiln also specifically admonished new underwriters of the role of judgment in what he termed the two essential lessons in reinsurance (1991:8),

“...first, the necessity to develop trust, and secondly, the fact that reinsurance underwriting is as much the art of underwriting people (assessing the quality of your reassured) as the science of underwriting facts.”

The quality of the underwriting assessment thus includes gauging the trustworthiness of one’s information and business providers. As can be seen from the above examples, information in the risk market is evaluated through reliability based on the underwriter’s reputation, leadership role and past performance. If a particular company is known for treating risks in a certain way, then behavior contrary to that style would be all the more noted. For these reasons of multiple nuances and judgment of character, face to face communication, negotiation and discussion among brokers and underwriters are critical.

Trust plays such a large role due to the limited time and resources that can be devoted to assessing each and every risk an underwriter is presented.<sup>52</sup> Indeed, trust is employed in some cases as a proxy for assessment. Tim Madden, a chief company market underwriter, expounds on the nature of trust in this highly competitive environment (Challis, 1999).

“...[those] who are hungry for more business are having to make immediate decisions about whether to accept a risk based not on his analysis of the business but on whether he trusts his relationship with the broker or the insurer that produced it.”

Within the Lloyd’s market, trust is also important among managers and underwriting staff. The Lloyd’s underwriter, more so than the company market counterpart, has the responsibility, independence and the authority to make decisions on the spot. In some cases “rogue underwriters” appear (an analogue to rogue traders), underwriting much more capacity than they have been authorized to use. At the same time, the market is quick to know of such aberrance through brokers making their rounds.

A final word on market relationships cannot avoid the fact that a certain amount of expertise movement takes place in London among firms. One “looking glass” transfer is from broker to underwriter, and vice versa. It is not unusual to have become an underwriter at a leading firm after serving as a broker for a number of years.<sup>53</sup> Such transfers provide a fluid expertise base in which relationships, roles and market knowledge are dispersed and consolidated through movement among firms of key

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<sup>52</sup> Using trust as a proxy for assessment has also been observed in the venture capital industry in the United States (Scherer, 1999).

<sup>53</sup> Some market practitioners claim the prestige value that accrues in making the switch.

personnel. Another method is more direct, that of underwriting staffs changing firms.

Liberty Re forms such a case.

Provided with capital from its American parent Liberty Mutual, Liberty Re was set up in the London market in 1997 and specialized in property catastrophe excess of loss. While the largest start up reinsurer in the history of the City, it was also obligated to provide a strong return to satisfy its corporate shareholders. Due to the extremely competitive trading conditions from an excess of capital in the reinsurance market, Liberty Re stopped trading by 1999. Its Chairman, John Engestroem, was a weathered reinsurance executive in the City. He had worked in the London market in his early years at Scandia Re, and then became a long serving chairman of the Mercantile and General Re (the UK's oldest surviving reinsurance company). When Swiss Re repurchased the M&G in 1998, Engestrom transferred to the fledgling Liberty Re as chairman. He now serves as head of Bermudan reinsurer Tempest Re. And of the underwriters? The London market contains substantial pores for roving talent. Robert Johnston, lead property underwriter for Liberty Re, moved with several key team members to Copenhagen Re in London. The leading members of Copenhagen Re responded by forming a new group, Danish Re. Throughout these changes, relationships for the most part form part of the permanent assets of any one of the personnel. New business plans and objectives may be formed, slightly different business cultures may prevail, but it is the market expertise, embedded in tacit knowledge, talent, and relationships which is highly coveted.

As they seek to justify their own positions in the corporate hierarchy, underwriters strive to achieve firm wide goals in order to maintain the firm's attractiveness to shareholders (in this case increasingly corporate shareholders as opposed to Names). One important measure both of the firm's level of risk aversion and of strategy in particular market conditions is the firm's target premium to capital ratio. Premium represents current income, but also potential for losses. Capital represents the ability to cover those liabilities in the future. Lloyd's, partially due to constraints barring the syndicates from investing in stocks, and due to its general receptivity towards new or unusual risks, has a high premium to capital ratio, hovering at 1.5 : 1.<sup>54</sup> Many other reinsurance companies hold ratios at par or slightly under. The premium to capital ratio is an anchor of revelation about the underwriting character of a firm - it is a cursory indicator of the riskiness in the underwriting. However, the premium to capital ratio in a particular line does not on its own reveal the context of other lines (aviation, auto, marine) in which the syndicate can smooth total returns.

Indeed, firm level strategies frame underwriter decision making, as underwriters are placed under a variety of short term corporate objectives. The strategic plan usually seeks advantage during a particular period in the market cycle or during the renewal seasons. These corporate goals could include top line growth (premium income), market share, or premium maintenance, thus affecting underwriters' decision and assessment priorities.

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<sup>54</sup> Income at Lloyd's is majority *underwriting* income, since Lloyd's can only invest in government bonds. Therefore, unlike many reinsurance companies worldwide, the syndicates at Lloyd's cannot offset poor underwriting returns with investment returns.

At the same time, the contingency of underwriting is not to be underestimated. Individual personalities and behaviors influence the social practices in the market. In a small market such as Lloyd's, individuals in one's own line of business, competitors and co-signers on the slip, are quickly recognized. Psychologically, judgment on contracts can be affected by moods, recent gains or losses, feelings of market control in writing a large commitment (and thereby garnering a large premium income), the effects of inebriation, and susceptibility to flattery. Indeed, one former Lloyd's broker commented that the art of the broker is to understand the personal dispositions of the underwriters to their advantage. It is the role of brokers to which I now turn.

### *Brokers and Relationships*

It can be said that brokers constitute the porous media through which the cat XL market breathes. This corps of intermediaries serve not only as purveyors of contracts, but also as conduits of information and rumor about market trends and market participants. Who more appropriate for an underwriter to query than the broker, who does the rounds? Whether client retentions are increasing, prices hardening (increasing), or clients changing their original contracts to include more or less coverage, the broker's informational value is critical to an underwriter's overall *market* assessment.

A critical relationship of power exists between the broker and the underwriter during negotiations of contracts and information. It is an essential ability of the underwriter to maneuver through the tacit market assets of judgment and relationships. An anecdote of the London market by a financial journalist illustrates the pressures underwriters face

with respect to garnering information to apply a weight of argument judgment (Challis, 1999).

“Reinsurers claim it is being made clear to them by brokers that if their demands are seen to be too high, then they may lose the business. Underwriters complain that they are being denied the opportunity to ask questions or scrutinize the producers’ books. They are being told they must either underwrite it, without asking too many awkward questions, or the broker will find someone else to replace him on the programme.”

In other words,

“From a list of 30 questions, the reinsurer must choose 10 of which he simply must have answers to... In the final outcome, reinsurers must ask themselves ‘how much money am I willing to lose so as not to be seen as a pain by my producers [brokers]?’”

The value of this negotiated information underpins the sustainability of the broker - underwriter relationship. Certain market social practices serve to reinforce this continuity, as described in Chapter 4. An underwriter may accept an “oblige”, or a piece of moderate risk business, from a valued broker in order to do a favor in the context of a beneficial business relationship. There are numerous venues for broker – underwriter negotiation, not only at the underwriter’s “box” at Lloyds. Indeed, the multiple meeting areas in the City, particularly the Leadenhall market next to Lloyd’s become sites of intense commercial discussion.

The shifting power relations between brokers and underwriters have come to a peak in the last few years due to a spate of mega-mergers among brokerage houses. There is concern in the market that brokers may wield too great leverage vis à vis underwriters. One implication is the *restriction* of choice in relationships and the *enlarging* of the set of negotiations with each broker. A broker’s persuasiveness may become all the more clear

when a package of contracts are at stake, not simply one. It is not unlikely that underwriters concede substantial brokerage fees and cut rate pricing to satisfy the broker's stipulations for trade. One catastrophe underwriter stated at a conference "...brokers will succeed in persuading many gullible underwriters to pay 15% brokerage on catastrophe business which may well put those underwriters out of business." On the other hand, broker leverage also depends on the state of the market. During a market hardening, when there is less capital supply yet great demand for reinsurance, underwriters have substantial leverage. In a soft market, one in which excess capital is the norm, the opposite occurs as underwriters seek clients and the maintenance of market share.

Reinsurance practitioners also use "*payback*" in the risk market sense of expectation of client continuity. It refers most readily to the practice by a reinsurance client, once protected by a particular reinsurance company over a number of years, to build a "bank of premiums" over that time. This long term relationship, if effected to the satisfaction of both parties, might include a reduction in rates as a sign of good will towards continuity. When a catastrophe strikes that "bank" of premiums, and it suffers depletion, the reinsurer usually raises rates. The "payback" occurs when the client, instead of moving to a company with a less expensive rate, stays with the reinsurer. In this manner, payback is a way of postfinancing losses. When an underwriter negotiates with a broker, it is not uncommon for the broker to use payback in both its peril (number of years at present premium to compensate for expected losses) and relationship meanings. However, "*post-financing*" losses through rate hikes has its drawbacks in that markets never remain stable

*and* brokers negotiate for their clients - in other words, there is never a guarantee for underwriters that rate hikes will be sustainable in a competitive market.

Some market practitioners consider it impossible to *pre-fund* losses in a competitive market and state it would go against social market practices if they attempt to do so.

Therefore, social practices and broker – underwriter power relationships form a routine of decision behavior. From an outsider’s perspective, it would be considered prudent to pre-fund losses. From inside the risk market, it would contravene an accepted social practice.

As one non-marine manager from Swiss Re UK (Grahame Dimmock) stated,

“London underwriters are already, I repeat, condemned to the continuous and unprofitable pursuit of satisfaction through payback. Any underwriter who tries to break this cycle is either ostracised by the broking community, or is told that his position as lead is to be put to the test of ‘consensus rating’ amongst the six (or so) largest lines on the slip. More than one London broker has boasted to me that it is he who sets catastrophe pricing levels, not his Lloyd’s leader. So the poor underwriter who decides after attending this seminar that he must begin to fund over the next 10 years for a doubling of damaging North Sea storm surges will be in for a very frustrating time.”

The quote highlights both the year to year pressures and variability of the business, the conditions of the market to affect broker – underwriter relations, and the powerful leverage of the broker to include or exclude underwriters from business. On the other hand, reputation, in the relatively small world of established cat reinsurance players, is a valuable asset, and one that syndicates and London market companies are keen to display - through their stock rating, ranking at Lloyd’s, or turnover.

## *Market Cycles*

Over the course of the empirical research, it became clear that market cycles represent the greatest driving force in *catastrophe risk* contract pricing and decision making. This influence is greater than firm level strategies or the personal risk assessment by the underwriter facing a new or renewable contract. It forms the basis for many of these decisions, especially as they find context in the strategic plans of the reinsurance syndicates. At the time of writing, the catastrophe market has been experiencing a continued slump in demand and great competition after Hurricane Andrew in 1992. Eventually, cut rate pricing has become the norm in order simply to maintain market share. Underwriting “discipline” or assessment based underwriting, does not fare well in highly competitive market conditions. Underwriters must decide whether to accept clearly underpriced contracts, or else do without the incoming premia.

It is critical to note that the current market capacity for cat XL is too large for return to capital by any particular firm to be sustainable over the long term, especially if they accept risks they judge are underpriced. Indeed, several market practitioners described the current, long standing soft market as needing a “good solid catastrophe” in order to take out reinsurance start ups and other players delivering capital to the market. At the same time, the assessment of the present is taken only against memory of the past nature of market cycles. On the theme of expectations in how the market might turn on the basis of one catastrophe, one market practitioner noted (*The Review*, 1 June 1998),

“There was a time, two or three years ago, when that was the market observer’s cocktail party prescription for the plunging rates in property catastrophe reinsurance. Not even party punters will say this anymore. Nowadays, market observers are saying that even two or three decent-sized catastrophes would not be enough to pull rates out of their current malaise. It would take a deterioration across all reinsurance lines of business to bring discipline back to the catastrophe market.”

The quote provides insight into the changing expectations among underwriters as to the force of catastrophes to bring a change in the market cycle. It is interesting to note that the market has been through such slumps before, as briefly outlined in Chapter 4.<sup>55</sup> As in most market slumps in the past, the reach for future continuity in market pricing is foresaken for short term survival and market share considerations, engendering a vicious cycle of competition and frantic hedging activity. Such routines of market behavior invariably cause losses through the *condition* of underpriced risks in the marketplace. This repeated phenomenon of short term considerations promoting loss has led at least one editor of a trade journal to remark: “A market cannot learn.” (Rigby, 1997)

Essentially, in soft (over capitalized) markets such as the present one, underwriters compete fiercely, compromising judgment and assessment, and hoping against hope for the market to harden (capital to be depleted) in order to raise prices. Even the answer to the article’s opening hypothesis, that people learn, but markets never do, does not fully appreciate the power of trading conditions to cause decision making to simply become reaction time and again. Thus, when external catastrophes strike, as they inevitably do,

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<sup>55</sup> The difference with the current slump is its longevity and the emergence of a major new market hub of reinsurance capital in Bermuda.

the reinsurance suitors who were hot on (underpriced) market share are left with enormous losses.

Some underwriters at Lloyd's in particular view such market behavior as suicidal, and suggest such opinions openly. At the same time, they are themselves "captives of the market." Ian Agnew, the active underwriter of Wellington, a leading Lloyd's catastrophe excess of loss syndicate, declared (*Catastrophe Reinsurance Newsletter*, June 1999),

"...the cumulative effect on rates has reached a point where markets are now writing business at less than 55% of the premium we received three-and-a-half years ago...no account is taken of inflation, the coverage is wider and underwriters around the world seek to maintain market share. If that is not a recipe for disaster, then I would like to know what is...Historically the market always seems to be hardest hit with large losses, both in size and number, at a point when rates are at their weakest. It should come as no surprise to anyone if history repeats itself."

Another Wellington underwriter, Tony Taylor, remarked on the implications of market behavior for the willingness of private capital providers to perceive London as a prudent investment.

"When the implications of the unprofessional underwriting approach of many of the players in the world market come home to roost, we will see a number of very upset capital suppliers who will damn the prospects of the whole of our industry. In relation to any of the result cycles which I have experienced over the last 30 years, I would have expected 1998 to be the nadir of the present cycle. However, this time round, the loss depths may be more prolonged because of the new fashion of issuing multi-year policies.

For the first time in the history of underwriting cycles, underwriters, particularly in the reinsurance area, have given commitments to write business at an agreed fixed price for periods of two or three years, or even longer. Given that this has been done at a time when rates are at rock bottom, you may think this to be injudicious at best and stupid at worst; I leave it up to you to decide."

At the same time, Mr. Taylor admitted that his own syndicates "had been forced to write multi-year deals, 'if only to remain a force in the market.'" Therefore, while the individual underwriter, the "I" of the decision maker, may prefer certain choices, it is

“we” of the market that imposes to a great extent the decision set. At the same time, beliefs support a great deal of decision making in practice. Underwriters display a certain amount of wishful thinking and optimism in their prognosis of the chance of a disaster to their account. One London reinsurance broker expressed this view at a gathering of insurance practitioners:

“...most of us in this room have been around long enough to understand the way in which the reinsurance market always works. My “most likely” scenario for the future is based on what Dr. Tiedemann has called the ‘Bravado Syndrome’ in which there is the subconscious feeling that ‘it ain’t gonna happen’ and if it does, ‘it ain’t gonna happen to me’.”

Indeed, this optimism shows itself in various maxims of the Lloyd’s market and displays both an individual and group perception of risk assumption. One such saying displays the degree of emphasis on gains or losses. The underwriter might wryly admit to contract acceptance, “When the scent of the premium overcomes the odor of the risk.” There are also a fair number of sayings that target the verity of brokers to impart the true nature of the risk they are brokering.

Volatility in the catastrophe excess of loss market is the highest among all classes of business at Lloyd’s. These sudden swings are understandable, since catastrophes cause major economic dislocations. Indeed, according to a Lloyd’s survey, catastrophe excess of loss contract pricing has changed by 33% in just over one year. However, the pricing and loss outcomes in the marketplace also depend on endogenous conditions, not simply exogenous causes. As mentioned earlier, a critical internal driving force is the amount of

“capacity” perceived to be available in the marketplace, and the competition this engenders.

During the 1980s, as one former catastrophe underwriter remarked, “how much stamp went down” (the percentage on the slip) was a barometer of a “successful” operation. That social standard is no longer in the main, as the disastrous consequences of the late 1980s and the spiral market attests. The Lloyd’s management introduced the Lloyd’s Risk Disaster Scenarios in just an attempt to temper risk optimism and account for the realm of the potential peril zones. As discussed in Chapter 4, these LDS comprise standard disaster outcomes. The Lloyd’s Market Risk Unit requests that the syndicates prepare their account to handle such events at the same time think of other catastrophe contingencies. Another interpretation of the RDS is as an institutionalized risk assessment routine to placate market raters, such as Moody’s or Standard and Poor’s.

### **The Risk Contract**

Insurance has been likened to a mutable technology (Ewald, 1991) and also as member of the class of legal contracts (Carter, 1991a). It is in the interpretation of clauses that the risk market and the risk contract overlap. The tangible policy is both, a flexible product, alterable to suit particular client needs, as well as a legal document parsing the space of future liability. Much of the bulk of catastrophe reinsurance contracting involves standardized wording. The contract assumes much more than simply an assumption of liability, however. The tacit expression of the contract is as an icon of market conditions,

competition, relationships, payback, power leverage, and the corporate culture of the trading market and of individual firms.

The backbone of the contract is the scope of cover (which hazards are covered), exclusions (what is not included), deductible (lower attachment point of layer), and limit (upper attachment point of layer). These provide a level of liability to the reinsurer, and a ready reference of maximum liability. It is the most basic and standardized information passed along for reinsurance considerations. Contract wording may fall to either brokers or underwriters, thus contributing to the possible alterations of the main template.

One of the most important clauses in the excess of loss contract refers to *each and every loss occurrence* within a specified period, as mentioned in chapter 4. As an example, a loss occurrence for an earthquake peril is 172 hours, while for windstorm, it is 148 hours. This *time definition* of a loss occurrence partially solves the problem of the definition of an “event” which plagued catastrophe reinsurance underwriters in the past.<sup>56</sup> Thus the catastrophe has as its coding reference not only severity and probability, but also duration, in “insurance time.”

Disputes are not uncommon, however, since the reinsured is requested to name when the hours clause should start. If damage to property occurs after the hours clause has expired, then the reinsured may activate a reinstatement. It is not unusual for clients to pay in advance for one reinstatement with their normal coverage. It becomes difficult to agree

on liability when multiple perils occur, or to identify the chain of causality of damage in time and through which perils. Whether or not damage is caused by one “loss occurrence” or two can have considerable financial consequences for the reinsurance company (Søren and Etkin, 1997).

The contract also contains an errors and omissions clause that exonerates the broker from information about the risk that he or she did not know. This separation of information known from not known can become cause for cancellation of the contract. The underwriter must be aware of the cancellation conditions within a specified period and the implications or weight of the missing information on the overall evaluation of the risk. Moreover, the contract’s terms and conditions are susceptible to varying interpretations by the client, some of which may allow action not intended by the underwriter. These interpretations reveal themselves when disputes arise over coverage and payment terms, or liability for particular kinds of damage. Different legal definitions of perils and their causes can substantially change the claims space for the underwriter. For example, interpretation could differ on what is considered a “flood,” thus merging questions of physical causality and financial liability (Butler, 1998).

The catastrophe excess of loss contract is usually active for one year (despite the multi-year deals currently in the market), with most renewals taking place at specified intervals throughout the year, according to geographic location of liability. The North American renewal season is in the beginning of January, Japanese renewals are in April, and

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<sup>56</sup> This event clause amendment to the standard XL contract was suggested by Robert Kiln during the

Australian renewals take place during July. These are periods of intense activity for underwriters and brokers, and also times of rapid turnover in decisions. The competitive state of the market is most quickly revealed during the various renewals, and serves as a point of reference for future market behavior. Therefore, the annual punctuations of these temporal compressions in the routines of the underwriter, with emphases on particular geographic revenue regions, further intensifies the need to make decisions quickly in the face of broker demands. It is only after the dust of the renewal season has settled that an evaluation of the changes in the market can be made. Resolution is never final, however, as brokers themselves use discourse and decision heuristics to take the market to extremes in their interest.

### **Relations Among the Categories**

The categories of underwriting catastrophe risk: evaluation of the peril, the vulnerability of the insured properties, the risk market and the risk contract, combine through particular driving forces in the market, notably competition and capacity. As highlighted in the empirical discussion, it is the risk market, with its negotiation of information and contracts, which dominates the underwriters' decision routines. The weight of the categories in underwriting decision making illustrates the relationship intensive nature of the mediation of financial expertise and financial transactions in the City.

In this section, Einhorn and Hogarth's analytical framework (1986) of alternatives, background, and cues to causality will be applied to underwriter decision making to

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1960s.

provide a series of stylized decision facts. Through this analysis, a further distinction will be made between conditions of market routines and the causes of loss to the company. This distinction between causes and conditions is subject to change in the assessment over time, and depends upon the causal framework and the weight of argument one uses to describe the alternatives. The basis for Einhorn and Hogarth's analysis is Mackie's causal field approach, i.e. that decision makers implicitly highlight active variables, while leaving others in the background in the assessment of risks. Depending on which is condition and which is cause, different alternatives are considered.

The categories of catastrophe risk suggest the separation of decision making in the mind of the catastrophe underwriter. As the experience of underwriting continues, the perceived relative weight of the categories and the cases in which particular categories become more or less important begin to form an assessment repertoire of alternatives against a tacit background. These alternatives, in the initial learning phases of the underwriter, also receive counsel from senior underwriters for case specific decisions. In the end, the art and science of underwriting remains the ability to assess not only the risk, but the risk market, mediated as it is by brokers. Therefore, an underwriter's "cues to causality" is a mixture of market and firm decision making heuristics, and the causal interaction of the categories for catastrophe risk. It became clear through the interviews that the risk market and the risk contract are two very salient anchors of reaction.

In assessing the decision alternatives, the underwriter takes stock of his or her categories - how can they be arranged in a way to satisfy client and firm objectives? The alternatives

also depend on the saliency of particular historical obligations that come to the fore - in the relationship with brokers and regulators, for example, or the compression of decision making that occurs during the renewal seasons. Particular alternatives become relevant in certain market cycles, leaving others unconsidered. At the same time, the judgment of trustworthiness and relationship continuity, in addition to the decision heuristics outlined above, and the market nature to follow leaders, could bring about extremes in the market through herd behavior. The alternatives at any particular time may not be so much judged as simply learned behavior.

The background, or the causal field, comprises the conditions of decision making - those factors that are assumed not to impinge on the decision maker's assessment. Through the empirical analysis, it appears that the condition - i.e. capacity in the market, becomes the cause of extraordinary losses when underpricing is rampant. The external cause, the peril affecting a particular region, becomes the condition not of the risk market, but the risk contract. Therefore, there is in fact a reversing of conditions and causes over the course of time, in different market cycles, and depending on the quality of market information. Therefore, the condition and the cause reverse and reflect one another in the underwriter's assessment over time.

The catastrophe excess of loss market is among the most volatile, understandably since catastrophes cause major "spikes" in the system of reinsurance. One Lloyd's survey found that cat XL pricing changed by 33% in just over one year. However, it is important to note that pricing and loss consequences depend on both external causes and internal

conditions in the marketplace, as the discussion on capacity illustrated. Market cycles, and the perception of turns in the cycle, create opportunities to exploit risk market conditions. It is a major driving force for pricing considerations, especially during the renewal seasons. The next section will outline several of the bargaining and decision making heuristics employed by underwriters, in order to broach the third pillar of Einhorn and Hogarth's analysis: the cues to causality.

### **Bargaining and Decision Making Heuristics**

In the bargaining between underwriter and broker, a number of decision making heuristics, as outlined in Chapter 5, influence underwriter judgment. Besides the relationship with the broker, the *marketing* of the risk by the broker to the underwriter has some parallels in the behavioral decision making literature. Framing certainly occurs, downplaying the risk's possibility for loss and highlighting the risk's acceptability and immediate income. The broker would wish to highlight the positive, income generating potential of the risk and minimize the danger of the potential claims space. Anchoring and adjustment in pricing decisions and peril evaluation also occurs, either from past pricing conditions or from similar contracts. For example, a catastrophic risk contract in a particular area is often priced with a comparative anchor from an analogous contract. Such a comparative shortcut significantly increases the number of pricing decisions the underwriter may make in a particular time frame. Anchoring and adjustment has also been noted to occur in climate forecasting as well (Glantz, 1988, Nicholls, 1999). Other forms of anchoring and adjustment incorporating formal knowledge involve a baseline

price offered by a catastrophe model, which is then adjusted (either upwards or downwards) to reflect market conditions.

Underwriters are also prone to the certainty effect, whereby a choice between certain income (premium) in the present, is weighed against the chance of uncertain future losses. The effect is also related to the reference of the underwriter's portfolio and the gain or loss anticipated by adding the additional risk. Market conditions also affect an underwriter's propensity towards risk taking. In a competitive market, awash in capacity, an underwriter may make riskier decisions. In less capital rich conditions, the underwriter's supply of reinsurance protection faces less competition, and thus usually has greater leverage in the broker - underwriter relationship. Without taking these changing conditions of the market into account, the behavioral decision making literature cannot account for changing practitioner practices.

Availability and the gambler's fallacy also find relevance in reinsurance underwriting. This applicability is especially apparent in catastrophic risk, where much reasoning on future expectations in the potential claims space is based on the saliency of past losses in a particular region. Moreover, there may be the tendency to think catastrophe events in any particular year decreases the odds of one occurring in the future - the gambler's fallacy. These decision heuristics highlight the importance of induction and analogy in creating a base of reference for the decision maker of catastrophe risk, as an anchor for expectations of the future. The late Robert Kiln cautioned against this type of reasoning, however prevalent in the market (1991:199).

“Of course, the reinsurer who is sure of his odds and is brave enough to underwrite after a loss rather than before a loss, may well make more money than a rival who does not get his odds right and reduces the premium he charges for a loss-free experience and catches the next loss. The art of catastrophe underwriting has often lain in taking a calculated risk after a high loss has been sustained and, conversely, refraining from taking business after a loss-free period when market pressures, due to optimism, have brought rates down below an economic level. The practice of assessing liabilities and the frequency of catastrophes can at least stop the prudent underwriter from committing this folly.

However, one must remember that because a catastrophe occurred in 1979, the odds of it occurring in 1980 can be unaltered. Sometimes the odds of it occurring can shorten: a major riot in one city can tend to spark off similar riots elsewhere. A major earthquake may have released pressures and thus reduce the probability of future earthquakes in the same fault, or it could increase pressures in other faults or further along the same fault.”

The quote illustrates Kiln’s receptiveness to alternative causal implications of an event, and the emphasis on playing against market behavior when the opportunities present themselves. He therefore advocated the combination of inductive reasoning with causal assessments of potential for loss, along with the courage towards risk seeking behavior when convention might not favor it. Elsewhere, Kiln cautioned that the sole reliance on past statistics could mislead if an assessment of current exposure is not taken into account.

The cues to causality for underwriter decision making focus on assessing the possible changes in risk market conditions - especially as they regard capital capacity. As mentioned earlier, an accurate assessment of a market is essential to the evaluation of corporate objectives. Critically, however, much of the information about market conditions is transferred through brokers and relationships. Social practices mediate the cues to causality, providing a reference of stability in the tumult of a reactive market

environment. The following excerpt from a trade journal illustrates this very tacit, uncoordinated dispersal of vital assessment knowledge of the risk market (Miller, 1998).

“Until three years ago, participants in the Lloyd’s market were content to trade without any quantitative frame of reference and with only anecdotal information to rely on. However, phrases such as “the hardest marine market in a generation” give only very limited information on the state of the market, and they give no information on issues that are crucial to anyone who wishes to adopt a rational trading position.”

The most salient cues to causality in anticipating a market turn are reports about rising prices in the deepest retrocessional reinsurance markets. These catastrophe reinsurers who protect the very top layers are especially sensitive to perception that a catastrophe may occur, impacting them most severely. Therefore, as retrocessional coverage becomes tighter (i.e. less coverage is offered on the market or otherwise prices are increased) other reinsurers of more exposed lower layers (i.e. more likely to have liability through the layer in the event of a catastrophe of a lesser magnitude) are likely to raise their prices. In this cue to causality, it is not simply the personal perception of the individual underwriter. Indeed, the market as a whole follows the same cues, and such group perception leads to an interesting exchange of dual identities of the underwriter, as the “I” of his firm, and of the “we” of the London market - the market that shares the distribution of the total risk.

The following two quotes illustrate this causal perception of market turns. A financial journalist and a leading Lloyd’s underwriter both comment below.

“Many find it hard to restrict their exposures when rates are low and are anxious about the consequences of losing market share if they restrict their findings. But successful underwriting requires that risks are properly priced and it follows that underwriters who can make an accurate assessment of the insurance cycle will be more likely to produce higher returns than those who view the cycle passively.” (Miller, 1997a)

“Active underwriter Bill Rendall noted that there were signs that the ‘bottom of the cycle is either here or not very far away. We remain confident that the defensive underwriting of the syndicate’s staff will prove itself to be the cornerstone for future opportunities as the reinsurance market returns to its senses...1999 may prove a turning point in the underwriting cycle for non-marine business. The retrocession market has hardened and this is usually an indicator that underlying rates are to rise.” (*Catastrophe reinsurance newsletter*, June 1999).

Bill Rigby (1997) brings another perspective to the causal framework, the recognition that the market and the individual underwriter are at the same time in cohort and in competition. The sum of all underwriters is the *catastrophe market*, yet there are very few noticeable points of control. The *leading* underwriters were seen as stabilizers, but even today, this stability has markedly decreased as internal imprudence and external, rapid and demanding changes (such as accompanied corporate capital) produce a high level of uncertainty in market movements. Partly to offset this uncertainty, consolidation has occurred among brokerages and among reinsurance companies by grouping resources, capital, and market expertise. At the same time, repeated market practices to post fund losses, underprice contracts, and prioritize market share underwriting rather than risk evaluation prompted Rigby, a former editor of *The Review*, a reinsurance trade publication based in London, to offer these comments in 1997:

“Some of London’s underwriters and brokers debated the motion last month that ‘The London market never learns’. The motion was defeated (of course) but few present would seriously argue with the proposition if they were not speaking in public.

Not on the basis that nothing has been learned: it is clear that many individuals and companies have made great advances in their approach to underwriting and handling of claims. The proposition has no counter because of the nature of a market. As Brian Rothwell, an insurance consultant, said at the debate: ‘Individuals can learn, but a market cannot. A market is not a learning organisation. It is not even an organisation – it just is. It is not a market’s role to think, or be proactive, or have a vision. All it can do is act and react on the basis of yesterday’s knowledge, in sudden leaps. It does not have a leader to

any stabilisers. There is little room for trust or team playing because internal competition is too great.'

The global reinsurance market acts in this way, and London is only a prominent manifestation of this. The fact that rates keep on plunging is ample evidence that the market cannot help itself. The only difference this time is that more people in the market know what a mess is likely to result.

Specialist companies find themselves particularly under pressure: what can they do if rates are too low but they have no other area of business to compensate? Common sense says to withdraw; behavior learned in the market says 'keep going, things might get better'.

But history says they will not get better, at least not until after they get a lot worse. When the next round of insolvencies happens it will simply be the market exercising its own natural selection. Individuals and companies should strive to be better learners than their neighbors; but the market as a whole cannot learn, and it never will."

It is such assessments of London market decision behavior that provides the integration among the categories of underwriting catastrophe excess of loss, the dominance of the risk market, and embedded routines of behavior. The herd mentality of the "we" when given a slip to sign by a broker and faced with a decision to focus on premium, market share, participation in the risk subscription or to face ostracism by foregoing certain risk contracts. As the market becomes increasingly competitive, the presence of the "we" outweighs the power of the "I" to make decisions that outlast immediate market pressures. This phenomena in the catastrophe market is all the more highlighted as exhortations to maintain underwriting discipline goes unheeded. The collective causal frameworks reinforce embedded decision routines.

Currently, the categories themselves are changing, moving the causal field into a different arrangement, one that may catch practitioners unawares. Such changes have been mentioned, and include more intensive use of information technology, greater market

coordination, a larger number of mega loss events, and the development of securitization. These changing market conditions, for which underwriters' categories and their tacit cues to causality do not emphasize, may lead to surprise in that market decisions may not bring about the effects imagined. One parallel in another financial services industry is the recognition among fund managers that technology stocks do not respond to the cues to causality in stock movements of more traditional stocks (cf. Warren Buffet's failure to recognize the new stock market mechanics with respect to technology stocks (Edgecliffe-Johnson, 2000), or the falling stars of mutual fund performers (Syre and Stein, 2000)). Again, the condition and the cause of loss may reverse in the assessment over time, especially when the categories themselves are changing.

The cues to causality are similar to Ayling's Egyptian anecdote of the reliance on particular signs in order to forecast future weather patterns, since such cues have been correlated to weather changes in the past (Ayling, 1984). If indeed conditions are changing, then the old cues to causality become unreliable guides to the nature of future activity. However, market routines of behavior, once learned and accepted in a social context, become very difficult to change in the absence of shocks to the system. These shocks for reinsurers came in the form of Hurricane Andrew, asbestos, Piper Alpha, corporate capital and abrasive lawsuits from Names in the UK, Canada, and the USA.

The scandals in the London market, such as the lawsuit by Names, and the slow processing of claims, challenge Lloyd's and London's credibility and reputation among reinsurance centers. The governance of Lloyd's has changed – with the new City

financial regulator, stronger centralization of power within Lloyd's, and the implementation of particular routines of internal examination of adequate reserving and accounting. With the dominant presence of corporate capital, Lloyd's syndicates are accountable to external, and in some cases American systems of corporate financial governance, demanding shorter term results and more patent delivery of sophisticated financial codes of accountability. On the other hand, the competition from securitization is also an impetus to exhibit greater financial capacity and consolidation. By some market practitioners' accounts, securitization will not allow the market to raise prices after the next large catastrophe. Indeed, this cue to causality has already been refashioned towards expectations of a plateau of prices the market will have to accept post catastrophe in response to the presence of securitized coverage offering protection on the highest layers. The persistence in underpricing continues.

## **Conclusion**

The categories of catastrophe risk underwriting were proposed in this chapter as a means of organizing and analyzing the decision environment of the catastrophe underwriter.

These comprised the peril, the vulnerability of the insured properties, the risk market and the risk contract. The influence of the risk market in underwriting decision making outweighs the other categories and points to the importance of social practices, relationships, capital and tacit knowledge in the reinsurance world. Einhorn and Hogarth's framework of alternatives, background and cues to causality was applied to the risk market, in order to derive stylized decision facts of the catastrophe underwriter.

These stylized decision facts include the emphasis on postfinancing losses, market share

underwriting, dependency on past loss records, herd behavior, reliance on lead underwriters, and trust as a proxy for assessment. In addition, a number of decision heuristics as described in Chapter 5 also apply to catastrophe risk decision making. These include framing, availability, the gambler's fallacy, and notably anchoring and adjustment. The heuristics supplement the stylized decision facts by pointing to tendencies at the level of the individual underwriter. The stylized decision facts, however, are a much broader descriptor, comprising structural as well as individual decision making patterns, and at the level of the individual, is informed by close dialogue with practitioners and participant observation of market practices.

The risk market is changing rapidly, however, exhorting a change in the weight of the categories in decision making practice. For example, a greater emphasis is being placed on formal knowledge via catastrophe models and scientific expertise, and less on tacit knowledge or market routines. With corporate capital from America engendering a re-evaluation of the nature of capital and its uses, Lloyd's and the London market have come to rely on the standardization of risk measurement and capital allocation. The information technology in claims processing and other administrative functions requires a further standardization of routines among syndicates, and the spatial coordination of financial flows. More so than ever, the London catastrophe risk market is becoming commoditized and standardized, translatable to the corporate contexts of the new capital providers. The integration of these trends, factors of the organizational milieu, and the spotlight on the individual decision maker is addressed in the following chapter. A

geography of risk, combining elements of theory and praxis, of structure and agency, is proposed as a way to conceptualize risk decision making practices.

## **CHAPTER 8**

### **Conclusions: A Geography of Risk**

## **Introduction**

This thesis began with a quote by Ulrich Beck on the propagation of catastrophe risk in modern society (Beck, 1996). It is Beck's contention that the reliance of risk governance on the probability calculus is partly at issue. This thesis addresses the use of probability in catastrophe reinsurance, part of what Beck considers to be the "frontier barrier of the risk society."

This thesis has joined two extremes by investigating low probability, high consequence natural catastrophes and risk decision making in those very institutions considered paragons of rationality: insurance companies. These centers of calculation are considered to employ the probability calculus to make precise balances between risk danger and risk opportunity, the "bean counters" of risk governance. Contrary to expectations that decision making hinges on financial calculation, the main driving forces in catastrophe reinsurance praxis are capital flows, risk market conditions, and relationships.

The main questions of the thesis concerned how probability and causality can elucidate the nature of catastrophe reinsurance praxis and the challenge posed by natural catastrophes to underwriters and to society at large. This concluding chapter begins by reviewing the themes of risk, uncertainty and causality against that framework.

Afterwards it proposes the building blocks of a geography of risk as applied to the catastrophe market and the reinsurance underwriter. It will also point to ways to improve the theory of economic decision making in natural contexts.

While the thesis probed theoretical issues in risk and uncertainty, it also faced a number of methodological issues in close dialogue with practitioners in an extremely competitive environment. As mentioned in the introduction, a semi – structured approach was used in order to allow the insurance practitioners to develop descriptions of their activities along lines they considered most important. Interviews among underwriters from different firms were taken as a type of normalization within a very particular market context, that of Lloyd’s. In addition, some of the most valuable perspectives came from those who interacted with the decision makers, instead of the decision makers themselves. This group notably included the brokers and the information providers such as Lloyd’s of London press. At the same time, participant observation was absolutely critical in order to gain a sense of the pace and dynamic exchange among underwriters and brokers in this traditional establishment. The competitiveness of the sector hindered detailed analysis of a particular syndicate. On the other hand, the aim in the empirical material to present a “landscape” of the underwriting community focused attention on the commonalities among catastrophe risk underwriting in general, promoting a stylized perspective of the individual facing risk and uncertainty.

The thesis developed the risk problematic as one of epistemological and causal structuration – the combination of agency and organizational structure – within categories of decision making. The causal framework of the individual decision maker motivates the framing and strategies of institutional discourse on risk. Many studies on the perception of social risk regard institutions, discourses and issue agendas as precursors of risk decision making (Hajer, 1995; Beck, 1992a). However, taking a purely institutional

approach does not elucidate how agency influences discourse as the result of decisions of those in positions of power. Conceptions of catastrophe risk are mediated through society by institutions comprising embedded contingency networks of tacit and formal obligations. Thus, risk problematics are shaped by the interaction between institutional structures *and* the force of agency. Indeed, risk decision making taken as actively constructing the demarcation of condition and cause in routines of expectation and assessment would inform a fundamental analysis of the nature of risk governance.

For these reasons (that of agency in risk framing, and causality in risk and uncertainty) it is not simply a geography of perils that needs to be considered with respect to reinsurance and natural catastrophes, but a geography of risk, comprising expectation, assessment, and decision making. The following sections of this chapter outline these three components to integrate economic decision making under uncertainty within institutional contexts, causal frameworks, and the routines of decision making praxis.

### **A Geography of Risk: Expectation in Catastrophes**

This section covers the nature of probability in expectation as expressed in the calculus of chance and as employed in catastrophe risk decision making. It is the first step towards incorporating causality in risk decision making. As described in Chapter 2, the literature on risk and uncertainty is diverse and specialized into different perspectives. The positivist literature takes realism as the philosophical starting point, enabling a standardization and classification of risks within a teleology of rational risk management (even economic decision making, is in a sense, the “management” of a class of risk

problems). Risk to the underwriter is the distribution of probabilities and loss values of a particular contract. Other literatures, notably sociology, view risk as a construct of social context and knowledge discourses. An underlying commonality of the two literatures is the meaning of risk as the *expectation of negative consequences*.

The formal insurance approach to risk has been strongly influenced by the statistical and positivist literature on risk management, favoring the standardization of risks through their expression in the law of large numbers. Indeed, probability, as calculated and used in the frequency in a series sense, is a critical input into the insurance industry. A bridge between contingent, conditional reality and the probability calculus is attempted via sampling and inference. In order to sample, insurance relies on recorded data. If a sufficient number of similar events has been recorded, then by using the law of large numbers (i.e. an estimation of the convergence of a set of data on events in a given time period), a probability of the variability of event occurrence in the future can be calculated.<sup>57</sup>

Significantly however, catastrophe perils such as earthquakes are not candidates for the law of large numbers since they rarely happen in the same place over time. Therefore, underwriters often employ subjective probabilities in the form of return periods. The return period is an amalgam of sparse historical data and the underwriter's own judgment. The main deficiencies of this approach concern the implications of catastrophe risk decision making in that: a) it provides perhaps misleading evidence of external reality, b)

when the catastrophe occurs, it occurs 100% in a given year and is not distributed through a number of years in space and time, c) it confuses searching for frequency probability with the search for subjective probability, or degree of belief in a certain outcome, d) its role in a framework of causal propositions such as in a system of insurance is not clarified. In other words, it is not just the number that counts, but how the number is used in the underwriter's model of market and peril reality. The probability is in this way *situated* in the institutional routines and decision making frameworks of the underwriter.

In the case of a), knowledge of the true number of cases is not known a priori, such as in the case of tossing a coin. In order to appreciate this perspective, a brief outline of the correspondence of probability is given. Assume that one does not know that heads or tails has an a priori (i.e.  $\frac{1}{2}$ ) chance in the calculus of combinations to sum to 1. After a long sequence of coin tosses, according to the law of large numbers (actually derived from the limit theorem of Bernoulli), the observed outcomes or frequency of heads to tails are believed to converge to the a priori or true probability. However, what if the sampling is not adequate to reach this conclusion, and we have a skewed set of heads to tails, so then by this experiment, the probability of heads to tails is not 50:50? In essence, induction is the epistemology because it is the a posteriori (inductive) observation, not the a priori (deductive) contemplation, which provides one with the true probability (Hacking, 1975). However, in this example of tossing a fair coin, there are no conditional influences, the outcome is a pure state of either heads or tails. Pure static states of the world forms the ontology of this doctrine of chances.

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<sup>57</sup> It is important to note that this estimate is biased by the quality of the data in accuracy both in geographic

What if one amends the sampling environment so that every time one samples, the world changes and one cannot know the a priori probability of occurrence? This situation mirrors the conditional world of catastrophic risk. Inferred probability is only valid over the series of time data from which it is taken. For example, a fault with recorded activity of 1 tremor over the past 100 years will have a return period of 1/100 as a rough and ready measure to the underwriter. However, 1/100 in any *one* year simply does not reflect the true risk due to changing conditions or factors promoting earthquake activity. Moreover, it is important to remember that it is not simply the occurrence of the external peril, but the particular geography of impact that is critical to the underwriter's expectation of loss.

The French poet Mallarmé once commented that a roll of the die does not annul chance (Hacking, 1975). Indeed, as Keynes observed true chance (or true uncertainty) is not something that can be predicted from a closed set of possibilities, as in most dicing and sampling games, such as drawing colored marbles from an urn. In these games, although there exists a consistent framework in which to compare events, the fact that i) there is a set number and distribution of outcomes a priori and ii) these outcomes are independent (do not impinge upon one another in a conditional sense) indicates that true chance is not represented. Once there is a known set of options, the calculus of combinations and permutations can define an a priori probability that any given outcome will occur.

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space and over time.

In the case of b), a catastrophe occurrence is not spread out in time. Indeed, one defining feature of a catastrophe is its temporal concentration. In other words, the probability does not describe the effect of a catastrophe when it does occur, but rather is a heuristic to conceptualize financial flows over time, partly to compare among portfolios of risk.

As for c) inconsistencies abound in the use of frequency probabilities and the financial mechanism in reinsurance. It is subjective probability, informed by the inductive experience of recorded events, that guides the underwriter of catastrophe risk in terms of a return period. The return period is a heuristic of the insurance epistemology – memory of past events, within the causal framework of the risk market, is used to inform the shape of uncertainty.

The following two statements on the topic of catastrophe risk are taken from first, a catastrophe modeling consultant, and next, a reinsurance underwriter. They describe the nature of expectation of catastrophe risk as described in the thesis.

“One of the issues associated with using a large amount of information to support such decisions is that there needs to be some benchmark against which one can assess validity. We have benchmarks in our minds of what is relevant, and the problem in the insurance industry has been that we have used history as a benchmark against issues which are not historically valid.”<sup>58</sup>

“We were told windstorm '87 was a once in 300 years occurrence. But we didn't have to wait 598 years – we got another in 1990. What commercial organisation can afford to take a 300-year view on payback periods?”<sup>59</sup>

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<sup>58</sup> Tom Hutton, President, Risk Management Solutions, Wharton IT Conference, 1995.

<sup>59</sup> *Financial Times*, 6 September 1996.

These statements indicate why d) is also crucial. The role of probability in a causal framework, such as a reflection of the future, or entry as return period, is not clarified in reinsurance praxis. The probability estimate is used in order to fill a quantitative stipulation in the insurance mechanism. However, the number itself is a product of judgment processes in the face of uncertainty, and belies the decision making heuristics of which probability is only one input. Moreover, the underwriter's probability of occurrence also may not relate to the true probability of occurrence in a particular year whatsoever (if in fact that can be known – cf. Keynes' ontological discussion), but rather relates to the maximum probability the insurer would allow in terms of losses.

The institutional management of risk is goaded in its rationality by the probability calculus and the rise of statistics as a discipline. Statistics “tamed” chance, or aleatory uncertainty, into rational calculation (Hacking, 1990). Indeed, for Ulrich Beck “calculating a risk means disciplining the future.” (1995: 128) Out of the realm of statistical or Knightian expectation, risk becomes fortuna, or chance.

As discussed earlier, Knightian uncertainty characterizes those situations for which frequency probability calculation is impossible. It is conceived as a group of unique cases, an expectation wilderness. At the same time Knight remarks that one is not left without any map whatsoever. Indeed, the philosopher – economist proposes “habits of mind” in the face of decision making under uncertainty.

Knight does not mention the basis for these routines of thinking nor does he include knowledge in his definition of risk; his probability has to do with the classification of instances. As such, it does not describe the generation of expectation as founded on degree of belief in a particular future course. According to Adams, “Uncertainty as defined by Knight is inescapable: It is the realm not of calculation but of judgment.” (1995: 27) This thesis has argued that such belief is founded on inductive generalizations from past events and a causal framework of how things proceed (both in an informal, tacit sense and a formal, empirical sense). Adams states similarly in his study of risk perception (1995: 30),

“The future is uncertain and inescapably subjective; it does not exist except in the minds of the people attempting to anticipate it. Our anticipations are formed by projecting past experience into the future. Our behavior is guided by our anticipations.”

In this statement, Adams essentially confirms the formalized conceptual argument of this thesis: that induction *and* causality provide a shape to Knight’s uncertainty as lack of probability. Risk as the expectation of negative consequences cannot be seen without reference to the causal framework in which it is fashioned as a metaphysic, or belief in particular futures.

### **A Geography of Risk: Assessment**

In this section, the role of institutional routines is highlighted in the selection and judgment of information in Keynes’ sense. The origin of Keynes’ weight of argument is the deliberation of legal evidence and how information is represented and differentiated in logical terms. Keynes’ purpose was to derive, in the end, a “rational” decision making framework where normative decision making patterns could be suggested. Although it

may be argued that Keynes' approach is internally consistent, logical and coherent, it does not correspond to the interpretive reality of human decision making. Keynes used the following argumentation to describe the weight 2 of argument (from Runde, 1990),

“...I assume, however, that just as our knowledge of the evidence that enters into the premises of an argument depends on our individual circumstances, so does our ignorance of factors that we might otherwise have considered relevant. What matters is not the level of that ignorance per se, however, *but how this level will be affected with the acquisition of additional information.*” (my emphasis)

While Keynes' weight 2 of argument contains an expression of the relative amounts of knowledge and ignorance, it is important to point out that the *turn in judgment* with the addition of new information depends upon changes in the causal field, as argued in Chapter 2. The change in the causal field will affect the relevance and weight of information. For example, as the catastrophe excess of loss pricing by the market is perceived by underwriters to be dependent on rising prices in the upper retrocessional layers, this provides a cue to causality against a background of multiple market signals. However, if this causal field changes, i.e. a perception that rising prices do not cause a change in the market in fact, then the familiar set of cues does not decrease the level of ignorance.

Probability as judgment, due to weight of argument, provides an epistemic avenue to assessment: as focused on the *constellation* of information leading to a justifiable conclusion. This perception of an argument's *agreeable closure* has very much to do with the treatment of conditions versus causes in the sphere of assessment, influencing whether or not a new piece of information adds to the probability (or likelihood) of a

particular judged conclusion.<sup>60</sup> The point of the perceived closure, in other words, depends on what is taken as the causal field.

The causal field approach enables one to conceive of surprise as that which occurs when the cues to causality do not correspond to the changing categories of decision making. In other words, surprise is tied to the reflexive interaction between expectation *and* assessment, not simply expectation on its own. One example of surprise is the excess of loss spiral in catastrophe reinsurance and the enormous losses entailed by the market. The risk market was exposed when the external cause of loss, a string of natural catastrophes, struck the internal condition of undisciplined underwriting in the reinsurance system. Such internal market routines, a condition of loss, reinforces the imperative to recognize the organizational context of assessment, to undertake a program of stylized decision facts, based on the causal framework of practitioners, and not to simply relate catastrophic loss to external causes such as perils. It is important to point out that conditions are not simply assumptions, they are a *field* constructed during the initial process of sense making (Weick, 1995), belief formation (Baron, 1987) and reinforced by participation in social routines (Lawson, 1985).

### *The Mediation of Uncertainty in Assessment*

The assessment of risk and uncertainty in catastrophe underwriting, with its insurance roots in the statistical, frequency definition of probability, is theoretically based on the presence or absence of probability information, i.e. the capability of assessment in

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<sup>60</sup> In this sense, degree of belief probability or subjective probability is congruent with weight of argument

expectation. The claims space represents the symbolic integration of expectation and assessment of this uncertain financial liability. Expectation and assessment are also brought together in insurance praxis through the recognition of how the decision categories could combine to shield against the *possibility of loss* while at the same time promote the acquisition of premia through the acceptance of risk contracts. Indeed, sociologist François Ewald linked expectation to assessment in illustrating the insurer's approach to the claims space. He stated (1987, 199),

“In everyday language the term ‘risk’ is understood as a synonym for danger or peril...it designates an objective threat. In insurance the term designates neither an event nor a general kind of event occurring in reality (the unfortunate kind), but a specific mode of treatment of certain events *capable* of happening to a group of individuals...” (my emphasis)

The most favored route to hedge the lack of calculable expectation in Knight's sense is the purchase of further reinsurance and the maintenance of long term relationships with brokers and clients. As situated in the risk market, assessment involves trust and close proximity. Indeed, the failure of information technology to take hold among reinsurers points to the strong value of face to face negotiations. Economic geographer Nigel Thrift has observed in his study of the City (1994:330),

“...certain kinds of business talk, especially those involving a degree of uncertainty, still depend on face to face interaction because of the way in which they allow particular kinds of communication and negotiation to take place (including non verbal interaction), which are difficult or impossible to communicate or negotiate at a distance...There is, in other words, a ‘compulsion to proximity’ in much business conduct, which it is difficult to surmount...”

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probability.

The assessment of risk and uncertainty is mediated through relationships in reinsurance. One of the most salient, the broker – underwriter relationship, is characterized by negotiated information transfer. As shown in Chapter 7, obligations and social market practices may constrain assessment due to the essential tension of relationship versus return. For example, the broker can demand particular terms of the underwriter, who remains dependent for business contracts, details on the client, and market gossip. All this points to the increasing importance of what Thrift (1994) terms *relationship management* in the City, i.e. the decreasing tendency of business relations to be founded on emblems of class. Thrift described that (1994: 334),

“...the conduct of contact has become increasingly reflexive as trust based on common social background has been replaced by a more active construction of trust which involves working up and worrying about relationships. In other words, international financial centres are ‘interactional proving grounds’ (Boden, 1993) where there is often no set script with which to conduct business, and in which deals must therefore be worked out that will involve complex understandings, informal trade-offs, and anticipated tensions. Such deals still require face-to-face contact.”

Clark (1998a, 1998b), in his close dialogue perspective on the practices of financial elites in London, pointed to the tension between risk assessment, temporal constraints in decision making and “historical duties, reciprocal obligations and cross-organizational loyalties” of firms as well as the web of “obligation and reciprocity.” (1995: 13) In the “thick texture of relationships, events and places” trust and commitment are important. Indeed, the empirical work of the thesis found trust to act as a proxy for assessment. Through relations of trust and necessity, information is mediated throughout the market. At the same time, assessment may be vitiated when power relations, relationships and firm level objectives are brought to bear.

### *The Knowledge Dimension in Assessment*

Assessments have also been treated in the economic geography literature as interpretive schemas in the integration of tacit and formal knowledge. While Clark (1998a) emphasized the nature of commitment among market relations, it is important to note the flux in which reinsurance currently finds itself: the risk market itself has changed irrevocably, as corporate capital, much of it American, has introduced new codes of accountability and time contingent processing of risk market indicators.

The commodification of reinsurance through the financial markets as instruments of securitization, in combination with the mergers in brokerage and reinsurance and the rise of catastrophe models have decreased in the saliency of relationship based approaches and tacit knowledge credentials. At the same time that reinsurance is becoming more of a commodity, subject to fixed informational requirements, management scholar Martin Fransman (1994) encourages going beyond the information processing paradigm of transaction based exchange. He supports “tackl[ing] knowledge to get to a more robust theory of the firm.” One way to view firm level knowledge is to probe the causal framework of its employees.

Economic geographers Ash Amin and Patrick Cohendet have suggested (1999: 96),

“It is generally impossible for an economic actor to manage unambiguously a piece of knowledge from a given set of information, particularly if the actor operates in a context of imperfect information. It is also clear that different actors can deduce different structures of knowledge (even contradictory structures of knowledge) from the same set of information...Alternatively, new knowledge can be generated without new

information...In short, we cannot think of knowledge and information in the same way. Each concept has to be thought of in a specific way.”

Amin and Cohendet’s account of new knowledge being generated without new information hinges on interpretation. Though it remains unstated in their work, it is the *causal framework that shapes information into tractable knowledge*. Tacit and formal knowledge integration requires a schema of cues and expectations, all the while maintaining a dynamic reflexivity through processes of structuration between the individual and the organizational context. Causality should be the lever over which expectation/assessment and information/knowledge are linked. Indeed, Amin and Cohendet also go on to say (1999:97),

“More than inequalities in the distribution of information, it is the factors driving the creation and distribution of knowledge that are likely to shape governance mechanisms.”

While catastrophe reinsurance underwriters adapt to market conditions based on particular cues to causality and coordination, whether or not the market can learn over time i.e. reconstitute the nature of reinsurance according to fundamental changes, remains to be seen. Indeed, part of the learning barrier in the London market may be the repetition of social routines governing economic patterns of behavior. In this sense, catastrophe excess of loss as a product cannot be seen without its relationship characteristics. The reinsurance commodity is re-divided and distributed globally, parsing liability not only through time in the hours clause, but also over space through different reinsurance networks. This procedure mitigates the uncertainty of any particular catastrophe. At the same time, continuity of reinsurance relationships underpin much of the “diffusion of

uncertainty” with respect to the ontological ambiguity concerning catastrophe risk. Thrift commented on the importance of relative standpoints in the filtering of market knowledge (1994, 334),

“Market participants are indeed forced to rely on a combination of texts, analytical schemes, social networks and influential opinion leaders (e.g. popular gurus) to generate interpretive schemes, leading not only to an uneven spread of information about markets but also to an uneven spread of interpretations.”

Indeed, an underwriter’s assessment encounters a number of competing pieces of information (Weick, 1995). However, at the same time, the thesis has taken the approach to filter the main components into common categories, within which one places incoming information and filters particular signals and cues. The value of Mackie’s causal field approach is to emphasize that within different decision situations, it is useful to identify the active and the passive causality in underwriter decision making: what they identify as the cues to causality affecting their decision behavior. In this way, the causal field model is descriptive, while it could be prescriptive in the caveats brought to bear on routinized decision making within a rapidly changing decision environment.

### **Geography of Risk: Decision Making Routines**

The final component of the geography of risk are the decision making routines themselves. The thesis is sympathetic to Herbert Simon’s account of bounded rationality and Karl Weick’s sense making approach and warns that behavioral decision research, while illuminating particular decision tendencies, is fundamentally “framed” by its

emphasis on contravening expected utility. The thesis argued for a study of decision making as a *routine* or activity.

The routine is embedded in particular temporal and spatial coordinating mechanisms (within a cultural and organizational milieu), such as the temporal urgency of the renewal seasons and the need to diversify over geographic space. Indeed, reinsurance decision making is as much about *coordination* of the market through brokers and syndicates as *competition* within the market for the best terms and conditions. Moral hazard and adverse selection considerations are present among the underwriters' decision criteria, but the dispersion of market power through capital and consolidation among companies affect decision making outcomes.

Causal frameworks serve a fundamental role in decision making routines by fielding the decision maker's arrangement of choices, perceived consequences and possible implications. Moreover, causal frameworks help to categorize what is considered as risk in society, thus developing a business for insurance. It is curious that causality (in the mind of the decision maker) did not find itself as a core component of economic decision making theory or behavioral economics.

Indeed, the behavioralists' thought experiments employing urns contain the assumption that the distribution of possible outcomes is determined *a priori*, and can in theory be known. The objective of their experiments was to gauge the degree of aversion to differential knowledge of distributional arrangements. The studies were thus geared more

towards evaluating attitudes towards probability than investigating decision making under uncertainty. Moreover, the focus in the behavioral literature has been on a mathematization of experimental results, without much investigation of the construction of decision categories in natural settings. Ontological issues are not raised, perhaps owing to this positivist, experimental branch of decision research (Goldstein and Hogarth, 1998). This approach highlights the tractability and standardization of decision making as a class of problems in economics, rather than a description of decision reality. Such an ontology pervades the discussion of uncertainty in insurance— as a quantity that can be measured and reduced with increasing information (usually on the order of degree of frequency in a series, or statistics). Indeed, catastrophe thresholds in different situated contexts within society (i.e. technological, social, financial, etc.) are to a large extent influenced by causal expectations of what is normal and what is extreme, not a perception of probability per se.

Interpretation through the construction of decision categories draws contours around risk spaces as threats or opportunities, and demarcates the conceptual paradigms of the decision maker. In the case of catastrophe risk, these demarcations are financial and legal, as liability is parsed among relationships and obligations among parties to the risk contract. Without an appreciation of the practitioner's heuristics and decision categories, an understanding of market behavior remains obscured.

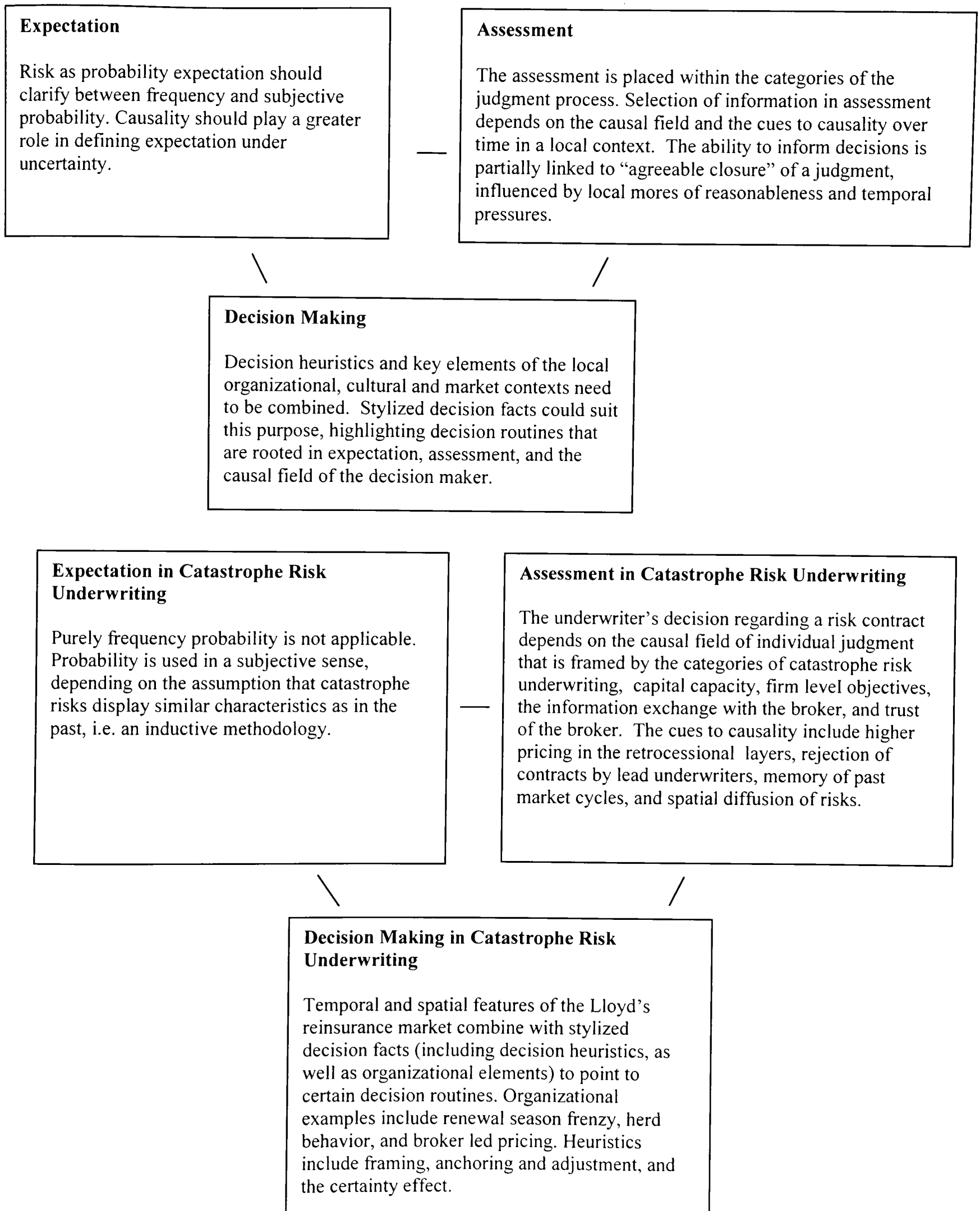
Decision making also needs to be viewed within culturally and professionally situated organizational and market mechanisms. These milieus contribute to the causal

understanding of the market mechanism. Their structuration over time and through shared market experiences (such as the excess of loss spiral) create shared causal spaces – composed of decision categories in the management of uncertainty. Ontological reflexivity, that continuous state of revising what can be known, hinges on the changing casual field supporting Keynes’ weight 2 of argument as described in Chapter 2. In order to improve decision making studies, the attention to causal fields and their reflexivity within institutional and decision routines warrants greater emphasis.

### **Model of Catastrophe Reinsurance Decision Making: Applying a Geography of Risk**

Below in Figure 15, the geography of risk is presented schematically and applied towards catastrophe risk underwriting. Not only does this model add to the investigations by geographers Clark, Thrift, Amin and Cohendet on economic and particularly financial decision making in local contexts, it also proposes a framework for future case studies combining individual and organizational elements of decision making.

**Figure 15: Geography of risk model and application to case study**



## **Implications for the Catastrophe Society**

It became clear from the empirical investigation that reinsurance losses from catastrophe perils come about not only from external causes (i.e. natural perils and vulnerability) but also internal risk market conditions – the underpricing of catastrophe risk, the priority to gain market share rather than assess risks, the willingness to follow a leader on a slip, and the market cycle of capital capacity. Underpricing and acceptance of poorly judged risks (in addition to social routines and webs of obligation) is in fact a *condition* of loss. This perspective is absent in the reinsurance and natural catastrophe literature, which mostly focuses on modifying external causes of loss through risk management at the local level or retraction of liability by reinsurers. Hardly a mention is made of the centrality of organizational decision routines and social practices in the realm of expectation and loss reduction.

Underwriting decision making finds its roots in expectation of the most traditional kind: that of statistical evaluation of frequency probability. A study of catastrophe reinsurance decision making may have been prone to emphasize probability as the centerpiece of the empirical, since the insurance epistemology relies on frequency probabilities. However, such a focus would ignore the participation of the practitioner in a situated market context, and would neglect the placement of probability within the causal structure of the categories in praxis.

The fact that catastrophe risk is notoriously difficult to quantify using frequency probability due to the scarcity of past data should moreover promote the view of a situated probability, probability as heuristic in a process of causal structuration among organizational epistemologies and the coordinating mechanisms of the market. The empirical material gleaned from interviews and secondary materials suggested four categories of catastrophe reinsurance (outlined in Chapter 7). These categories are influenced by structure and agency to produce a market routine of decision making practices. It also provided a perspective on the causal underpinning of choice, through a description of the practitioner's selection of and reliance on particular cues to causality.

Of the categories of catastrophe underwriting, the risk market holds the greatest weight in decision outcomes. Inductive reasoning of past market behavior under similar market conditions dominates the underwriting epistemology with less regard for the nature of fundamental change in the marketplace. Such market practices employing the past as a mirror onto the future generate an inherent propensity for surprise. The recent shift towards prospective underwriting, represented in part by the upsurge in the use of formal knowledge by catastrophe models, has provided the industry with greater sophistication for scenario development in the formal calculation of risk. However, competition in the risk market and the strength of market cycles often vitiate the application of such calculations to pricing decisions.

Indeed, although a transition is occurring in the nature of reinsurance in the City, the familiar cues to causality are continuously adhered to. Conditions are changing in the

mechanisms to finance catastrophe losses, such as the emergence of risk based capital stipulations, corporate capital shareholders, and the increased knowledge intensive market, but the causes of market drivers are largely perceived to be the same. Such cues to causality include indicators of future market “hardening,” the social routines of the subscription market and expectation of client continuity.

The assessment processes enabling the gathering and weighing of facts, pertains to the underwriter – broker exchange in the presentation of the file on the client and the questions asked by the underwriter: to know which questions are relevant in the short time with the broker is part of the underwriter’s tacit knowledge. The formation of the questions is made within the perception of the causal interaction of the categories of catastrophe risk. At the same time, the underwriter also performs an assessment of the *broker* and the client’s *underwriting team*. It is vital to consider the partitioning of the claims space as occurring through these relationships. Assessment thus combines tacit and formal knowledge, against the backdrop of the categories of catastrophe risk.

Uncertainty in this context relates to lack of knowledge not only of events as causes (i.e. data points) but also about events as conditions (particular combination of circumstances and dependencies leading to loss). This route is not one of classification of statistical data, as in the fire hazard (the root of the catastrophe policy). Rather, the underwriters must consider the generation of the loss conditions – the formation of “hazard communities” in coastal regions vulnerable to hurricanes and tsunamis, in earthquake zones, and in flood plains.

This “production” of social vulnerability to catastrophes is borne out in the substantial migration and development of hazard - prone geographies, such as along the exposed coasts of the United States. Building and settling in harm’s way, under weak risk management incentives, promotes another condition of loss. The impact of this latent shift in vulnerability also affects the activities of institutions within a certain square mile an ocean away, one that is global in its capital base and local in its practices: the catastrophes reinsurance market in the City of London.

On the other hand, it may be that insurers and reinsurers, as arbiters of risk coverage, may use the risk – condition as governance of the risk cause. Within an understanding of the responsibility for loss, the stipulations of the insurance policy can provide a certain governance by rewarding mitigation of loss potential. Indeed, the vulnerability of the particular geography to the hazard peril is a notable component of the total loss (Watson et al., 1996). The use of risk *as* governance is a fundamental basis of the precautionary principle. What might be needed is a re-evaluation of what is an assessment of natural catastrophes: the discussion can not only highlight the probability of loss, but must take into account mitigating the consequences of that loss.

It is this kind of propagation of Beckian risks – *as conditions and causes within decision making frameworks influenced by the combination of structure and agency* - that needs further study. In these overlaying conditions and causes, reinsurers also have agency in the promotion of the risk society, not only of its financial protection. By providing

reinsurance to support the development of vulnerable regions without risk governance, they are in fact contributing to their own and society's vulnerability to catastrophic loss.

It has been said that there is nothing like a catastrophe to generate a re-evaluation of norms and routines, and to motivate for change (Tickell, 1996). This statement underscores the importance of recognizing the nature of societal thresholds and the routines of decision making in different sectors and different geographies. For example, *dependence* on the internet and technology systems could rapidly decrease the threshold for catastrophe – as those systems would be unable to respond in the event of an emergency.<sup>61</sup> The context for the catastrophe within the coping methods of contingency and reliance should also be appreciated, as the background against which vulnerability should be viewed. For example, the stock market faces great changes often, and what might have been considered a catastrophe some years ago no longer is, since the reference and threshold for a catastrophe has shifted.

Insurance, as a type of metaphysical capital, or capital to accommodate beliefs about the future, is itself involved in the demarcation of risk and uncertainty in society. Through an exploration of the causal spaces among situated practitioners, as in a geography of risk, concepts for risk governance would find greater applicability. Through this study, the risk society was found to be a complex amalgam of decision routines, expectations, and power relationships. Indeed, the world of the catastrophe reinsurance underwriter

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<sup>61</sup> This potential for chaos has been scrutinized with respect to the millennial change in date, but not with respect to natural catastrophes.

mediates risk through the reflexivity of tacit and formal knowledge, systems of measurement and understanding, and networks of relationships within the market.

### **Suggestions for Further Research**

The geography of risk model is focused on combining elements of individual and organizational decision making under uncertainty. It puts forward as its major contribution the role of the causal framework of the individual within the categories of assessment and the organizational routines of decisions. As a generic risk decision making model, it could be applied in different case contexts to probe the nature of decision behavior. This approach provides a foundation for a formalization of tacit knowledge since it begins with the epistemological basis of uncertainty and the causal link in judgment and decision making. Moreover, it stresses that the local milieu directly influences decision behavior. Economic geographers may use the geography of risk to study other cases of risk governance in public institutions such as the UK Health and Safety Executive (HSE) or Department of Environment, Trade and the Regions (DETR) on issues such as road safety, biotechnology, BSE, or health and climate change. A comparison of the policy maker's causal categories of risk decision making could improve the assessment of options.

On the other hand, a study of another financial sector, such as banking, might benefit from an investigation into the routines of decision making, situated probabilities, practices of information gathering, and conventions informing the causal spaces of the practitioner. Another area of research could be the way in which knowledge management

is carried out with respect to expectation, assessment and decision making in firms. In such a study, there would be an emphasis on the creation of decision categories by practitioners, the role of the causal framework in delimiting and reinforcing those categories and the development of continuity and trust.

## **Appendix A**

### **Statement of Environmental Commitment by the Insurance Industry**

**November 23, 1995**

**United Nations, Geneva**

#### **Preamble**

The insurance industry recognizes that economic development needs to be compatible with human welfare and a healthy environment. To ignore this is to risk increasing social, environmental, and financial costs. Our industry plays an important role in managing and reducing environmental risk, in conjunction with governments, individuals, and organizations. We are committed to work together to address key issues such as pollution reduction, the efficient use of resources, and climate change. We endeavor to identify realistic, sustainable solutions.

#### **1. General Principles of Sustainable Development**

- 1.1** We regard sustainable development, defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs, as a fundamental aspect of sound business management.
- 1.2** We believe that sustainable development is best achieved by allowing markets to work within an appropriate framework of cost efficient regulations and economic instruments. Government has a leadership role in establishing and enforcing long term priorities and values.
- 1.3** We regard a strong, proactive insurance industry as an important contributor to sustainable development, through its interaction with other economic sectors and consumers.
- 1.4** We believe that the existing skills and techniques of our industry in understanding uncertainty, identifying and quantifying risk, and responding to risk, are core strengths in managing environmental problems.
- 1.5** We recognize the precautionary principle, in that it is not possible to quantify some concerns sufficiently, nor indeed to reconcile all impacts in purely financial terms. Research is needed to reduce uncertainty but cannot eliminate it entirely.

#### **2. Environmental Management**

- 2.1** We will reinforce the attention given to environmental risks in our core activities. These activities include risk management, loss prevention, product design, claims handling, and asset management.
- 2.2** We are committed to manage internal operations and physical assets under our control in a manner that reflects environmental considerations.
- 2.3** We will periodically review our management practices, to integrate relevant developments of environmental management in our planning, marketing, employee communications and training, as well as our other core activities.

- 2.4 We encourage research in these and related issues. Responses to environmental issues can vary in effectiveness and cost. We encourage research that identifies creative and effective solutions.
- 2.5 We support insurance products and services that promote sound environmental practice through measures such as loss prevention and contract terms and conditions. While satisfying requirements for security and profitability, we will seek to include environmental considerations in our asset management.
- 2.6 We will conduct regular internal environmental reviews, and will seek to create measurable environmental goals and standards.
- 2.7 We shall comply with all applicable local, national, and international environmental regulations. Beyond compliance, we will strive to develop and adopt best practices in environmental management. We will support our clients, partners and suppliers to do likewise.

### **3. Public Awareness and Communication**

- 3.1 Bearing in mind commercial confidence, we are committed to share relevant information with our stakeholders, including clients, intermediaries, shareholders, employees, and regulators. By doing so we will improve society's response to environmental challenges.
- 3.2 Through dialogue with public authorities and other bodies we aim to contribute to the creation of a more effective framework for sustainable development.
- 3.3 We will work with the United Nations Environment Programme to further the principles and goals of this Statement and look for UNEP's active support.
- 3.4 We will encourage other insurance institutions to support this Statement. We are committed to share with them our experiences and knowledge in order to extend best practices.
- 3.5 We will actively communicate our environmental activities to the public, review the success of this Statement periodically, and we expect all signatories to make real progress.

#### **Steering Committee**

General Accident, Perth, United Kingdom

Gerling-Konzern Globale, Cologne, Germany

N.P.I., London, United Kingdom

Swiss Re, Zurich, Switzerland

Sumitomo Marine and Fire, Tokyo, Japan

Uni Storebrand, Oslo, Norway

United Nations Environment Program, Geneva, Switzerland

## **Appendix B**

### **Interview Protocol**

Objective: The purpose of these interviews is to understand the context, from the underwriters' perspective, of underwriting catastrophic risk from natural hazards. These questions, therefore, take the form of a semi-structured approach, in order to learn from the underwriters and from the firms.

#### **Semi-Structured Interview Questions**

##### **Part I: Institutional Conditions (Infrastructure and Context)**

What is the financial structure of your firm? What are the ranges of the risks the firm underwrites as a whole? How would you describe the business and competitive pressures of underwriting cat risk? What is the size of the firm? What would you identify as the main institutional procedures? What is the nature of the information you seek and by which institutional channels do you obtain this information? How important is the firm to your underwriting business? Are you part of a team or directing your own decisions? How do you consult with other members of the firm and when in the decision making process? Does your judgement depend on the credibility of the information source? How much interaction does the underwriter have with the research group and/or catastrophic risk models? How does your firm handle systematic risk management? How would you find the British underwriting environment different from other countries (for example, USA)?

##### **Part II: Underwriting Conditions**

What are the steps to obtaining a contract? How do you interact with other underwriters? Is there a familiar pattern to underwriting expertise in a certain area? How is underwriting performance tied to salary compensation? What are the other incentives - end of year firm pool bonuses? What is your training and background? Do you have experience other than underwriting? How do you view what you do in your job as opposed to what you do in your personal life? Does your job affect the way you think about issues in your personal life? How do you use probability in your judgement assessment? What is the nature of your judgement and how much flexibility are you given? How are you familiar with the process to determine a probability under the different risks you insure, especially catastrophic risk? How does one decide whether a risk is insurable, is it an underwriter decision or a corporate decision in your firm? How does one assure whether information provided is correct on the part of the insuree? How is the force majeure clause used within cat risk? What are the choices for diversification? What constraints do you see in your job, and do you think your activities could be made more efficient or effective without and/or with certain other legal or economic incentives? What are the particular pressures of the 1 year underwriting cycle for cat risk? Does the emergence of securitization affect the way you do business? What is your opinion of the securitization trend? How many risks to you see daily approximately and are they diverse or concern similar dangers?

### Part III: Perception of Uncertainty

How do you classify a risk? How independent is the underwriter in classifying risks? What would be your definition of uncertainty? What would be sources of uncertainty in your business? How would you approach this uncertainty? Is there a sense of community operating in the same uncertainty, or can certain information provide an advantage to some underwriters? Is it an advantage to have similar model building standards and assumptions across the cat risk insurance industry? To what extent is the uncertainty methodological and to what extent inherent? What kinds of models (if any) do you think could express the uncertainty in a way you could use in your judgements? How are decisions made with minimal information?

## Appendix C

### Financial Organizations represented in Interviews

#### **Lloyd's Syndicates**

- Catlin
- DP Mann
- Harvey Bowring
- Kiln
- Wren

#### **Composite Reinsurers**

- Swiss Re UK
- SCOR Re

#### **Composite Insurers**

- Royal and Sun Alliance
- Factory Mutual

#### **Brokers**

- Benfield Greig
- Sedgwick

#### **Governance**

- Lloyd's Market Risk Unit
- H.M. Treasury

#### **Consultants**

- Eastgate Ltd.

#### **Information Providers**

- Jim Bannister Ltd.
- International Underwriting Association
- Jeremy Leggett/Solar Century
- Lloyd's of London Press
- Loss Prevention Council

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